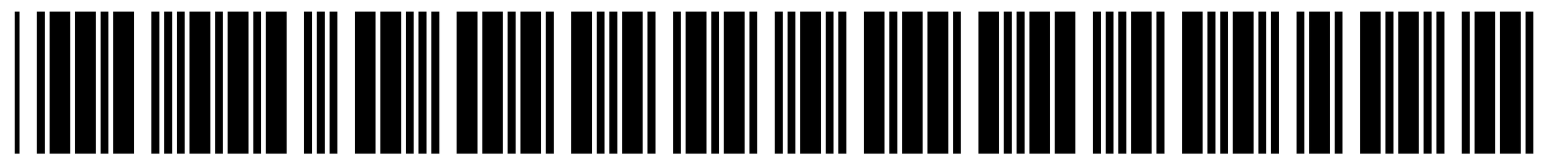
US005814535A

United States Patent [19]

Shimada et al.

[11] **Patent Number: 5,814,535**

[45] **Date of Patent: Sep. 29, 1998**

[54] **SUPPORTING MEMBER FOR COOLING MEANS, ELECTRONIC PACKAGE AND METHOD OF MAKING THE SAME**

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[73] Assignee: **NEC Corporation**, Tokyo, Japan

[21] Appl. No.: **573,131**

[22] Filed: **Dec. 15, 1995**

Related U.S. Application Data

[62] Division of Ser. No. 423,455, Apr. 19, 1995.

[30] **Foreign Application Priority Data**

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Jun. 20, 1994	[JP]	Japan	6-137581
Jul. 13, 1994	[JP]	Japan	6-161092
Jul. 22, 1994	[JP]	Japan	6-170628

[51] **Int. Cl.**^{6} **H01L 21/00**; H01L 21/70; H01L 23/34

[52] **U.S. Cl.** **438/122**; 438/121; 438/106

[58] **Field of Search** 257/706, 718, 257/720, 722; 361/709, 711, 720; 438/121, 122, 106

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Primary Examiner—Teresa Maria Arroyo
Attorney, Agent, or Firm—Whtiham, Curtis & Whitham

[57] **ABSTRACT**

An electronic package according to the present invention comprises a supporting member, an electronic device, a carrier, a substrate and cooling means. The supporting member includes a plate and a bottom leg for supporting the plate. A first end of the bottom leg is joined to the lower surface of the plate. The carrier has a hole for receiving the bottom leg. The electronic device is connected to the carrier and is attached to the lower surface of the plate. A second end of the bottom leg is inserted into the hole of the carrier. The second end of the bottom leg is joined to the upper surface of the substrate. The electronic device is positioned between the plate of the supporting member and the substrate. The cooling means is attached onto and supported by the upper surface of the plate.

6 Claims, 14 Drawing Sheets

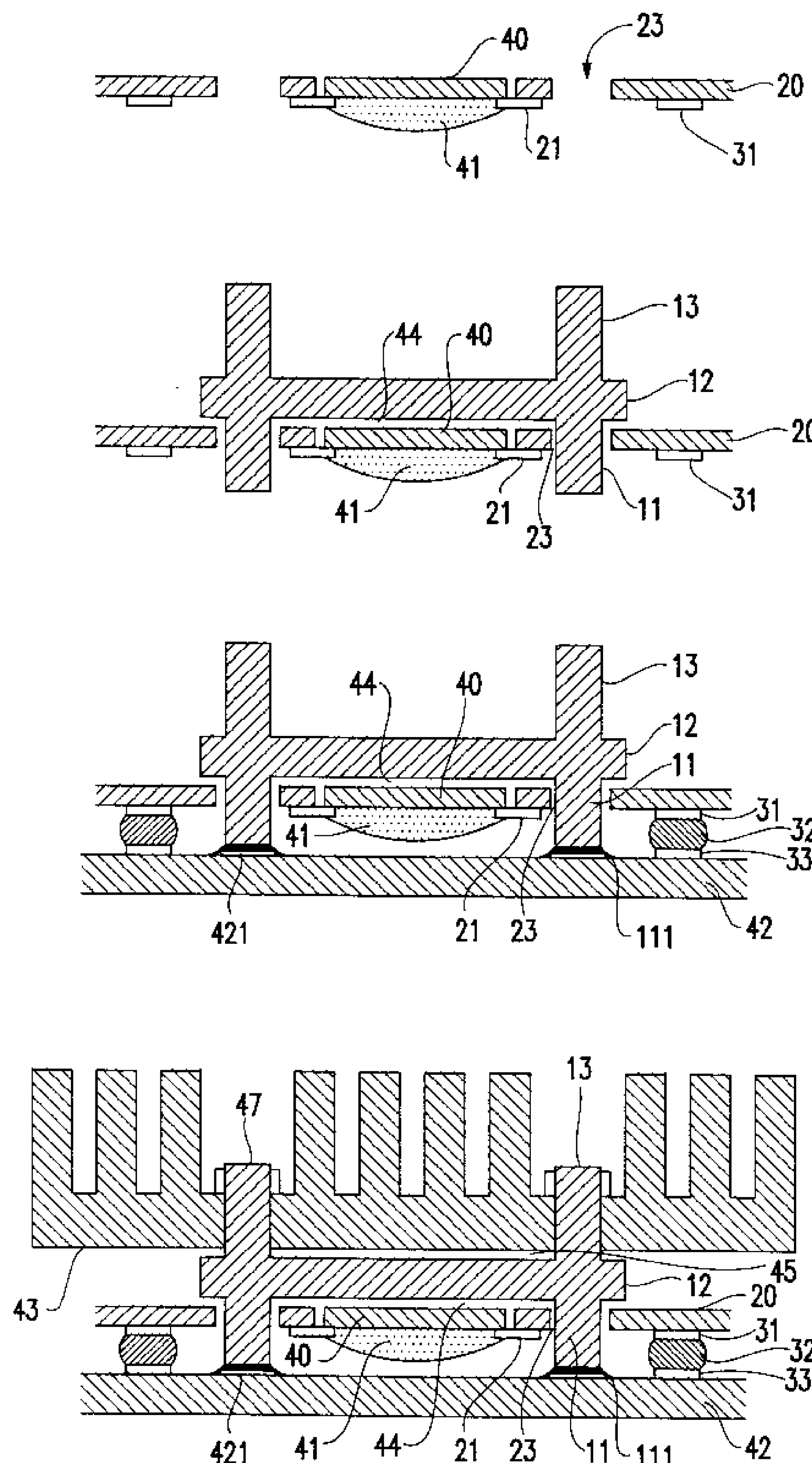


FIG.1

FIG.3

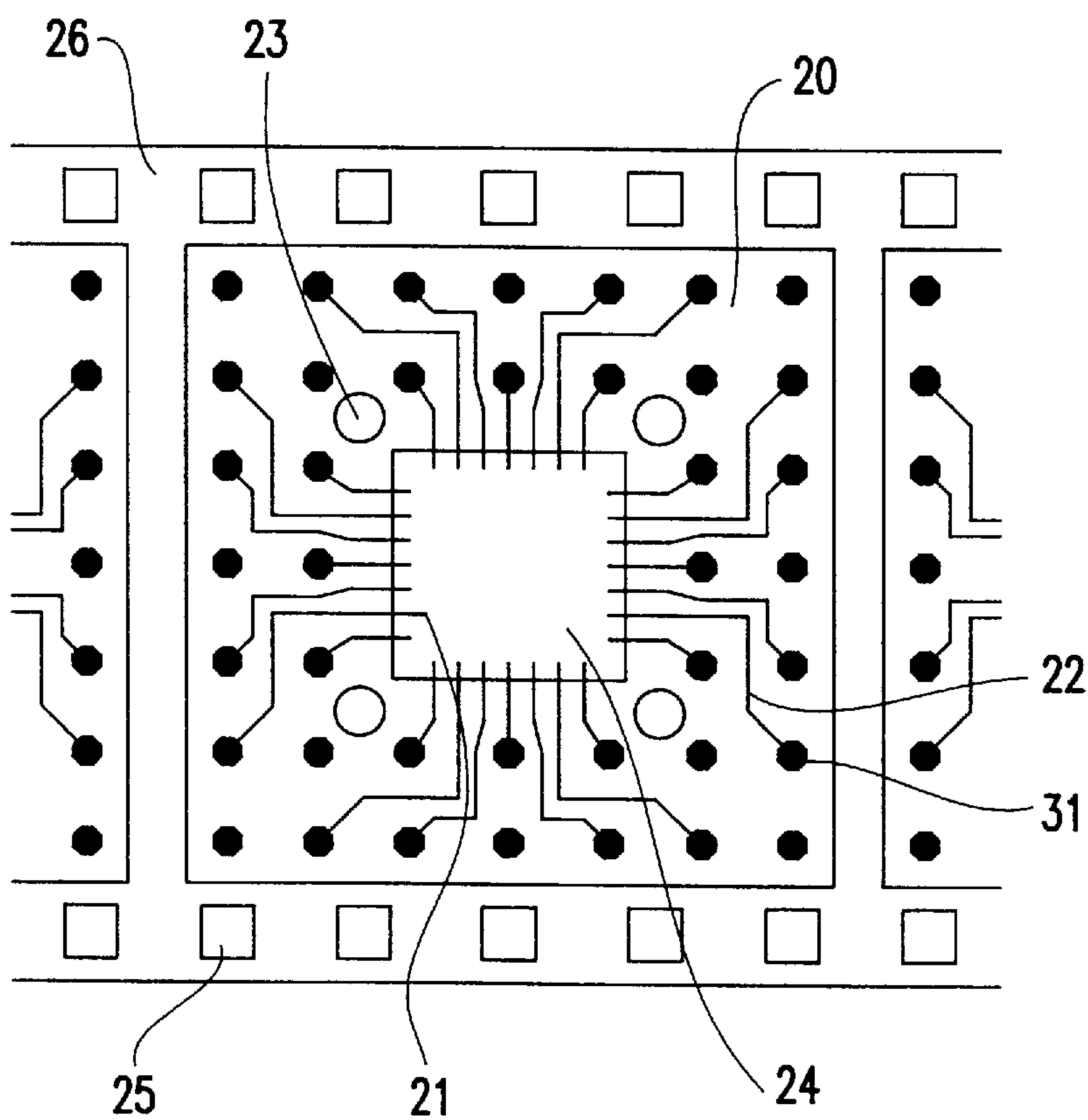


FIG.2

FIG.4A

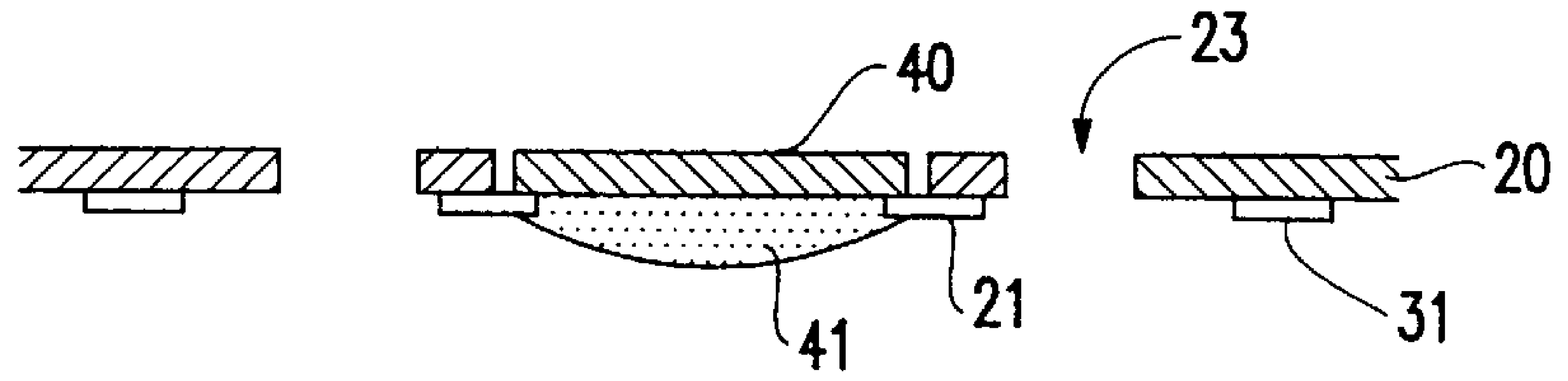


FIG.4B

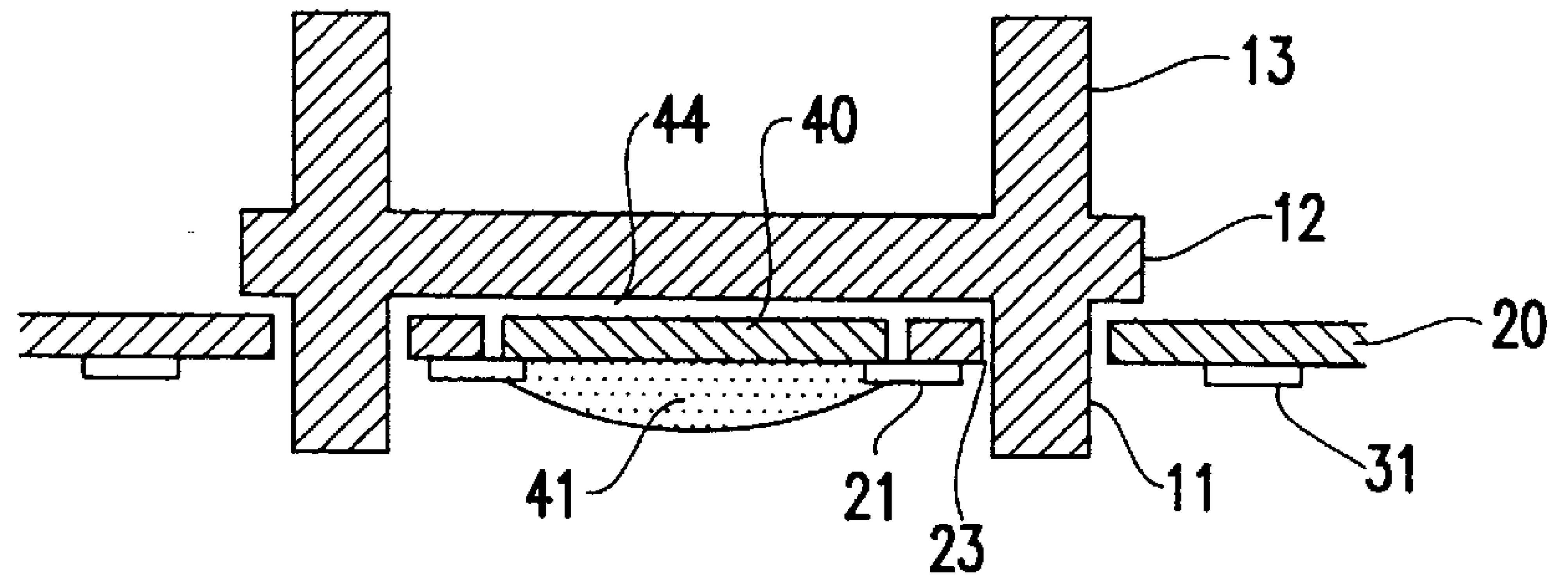


FIG.4C

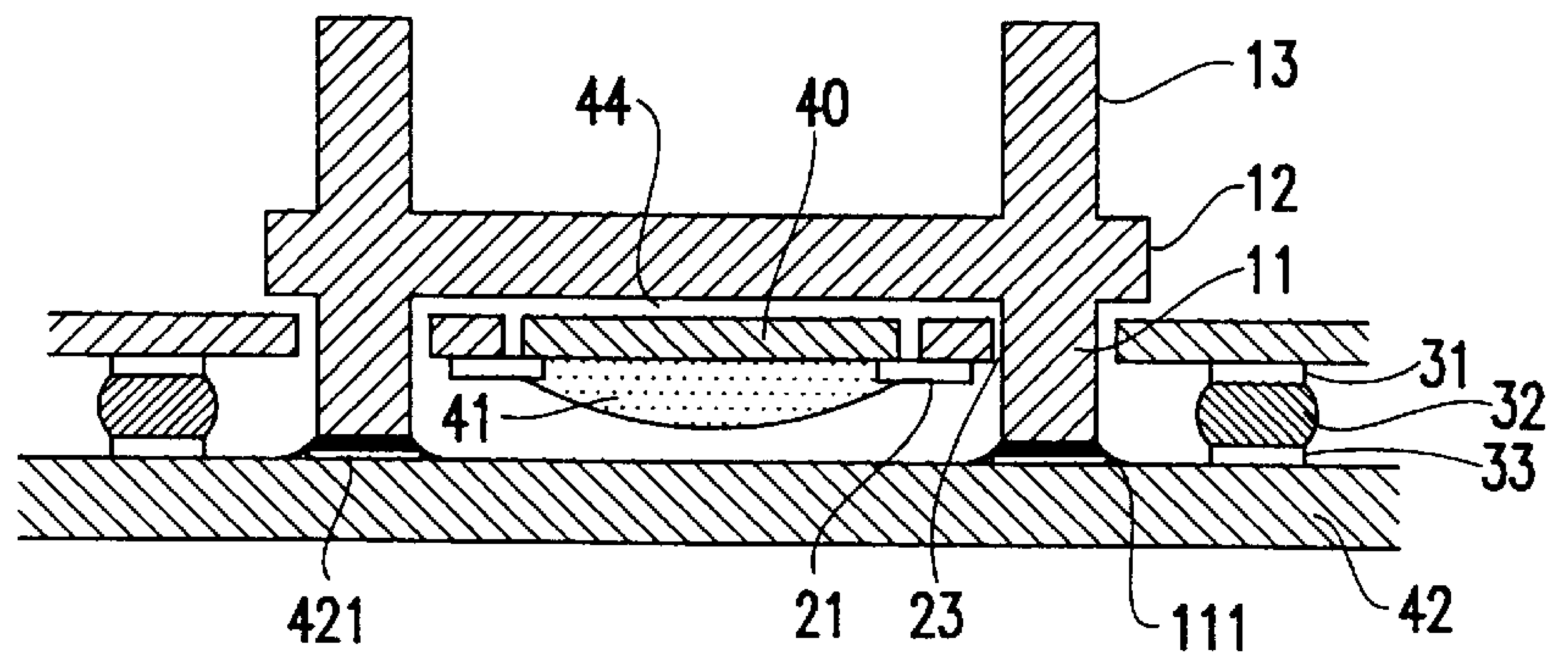
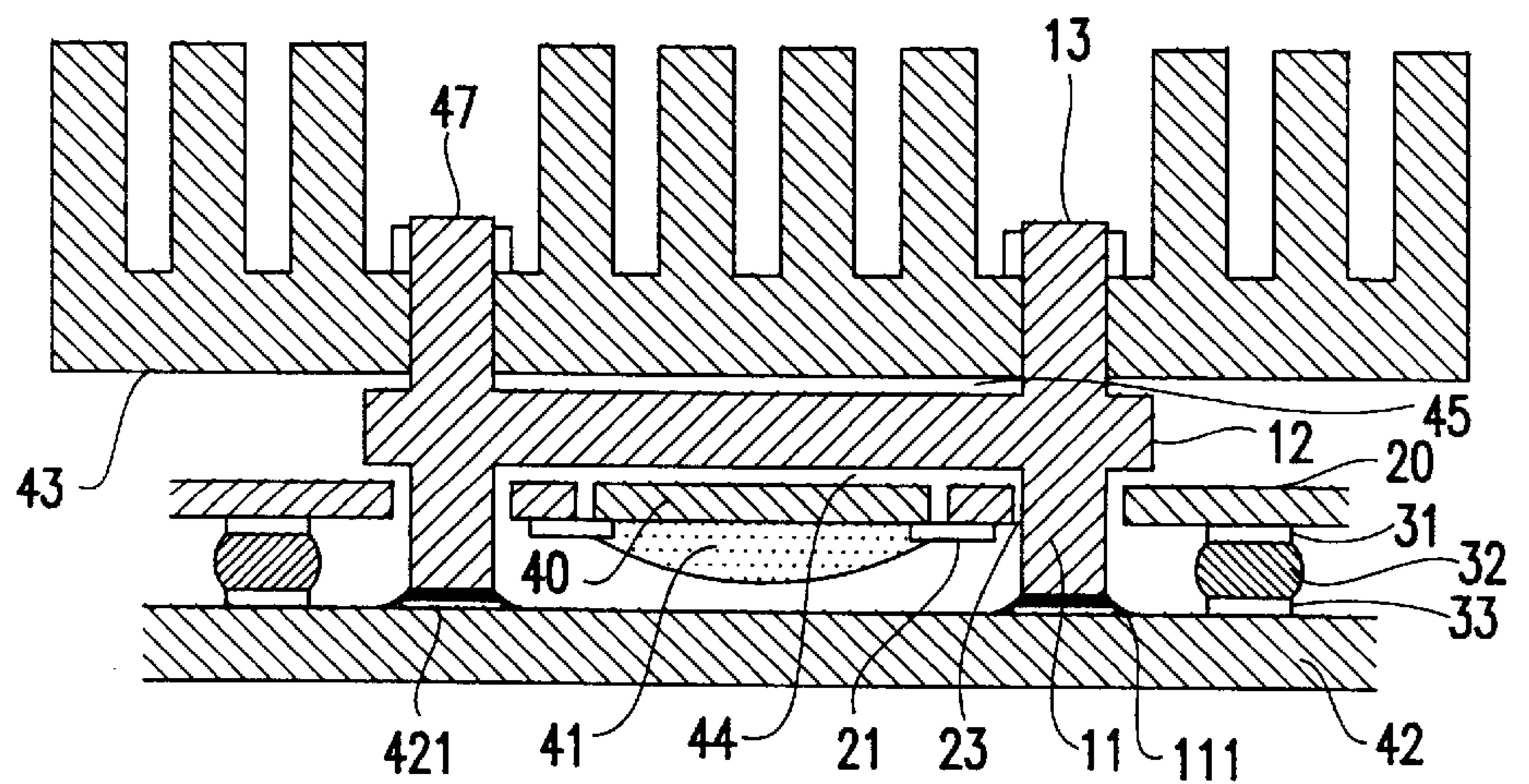


FIG.4D



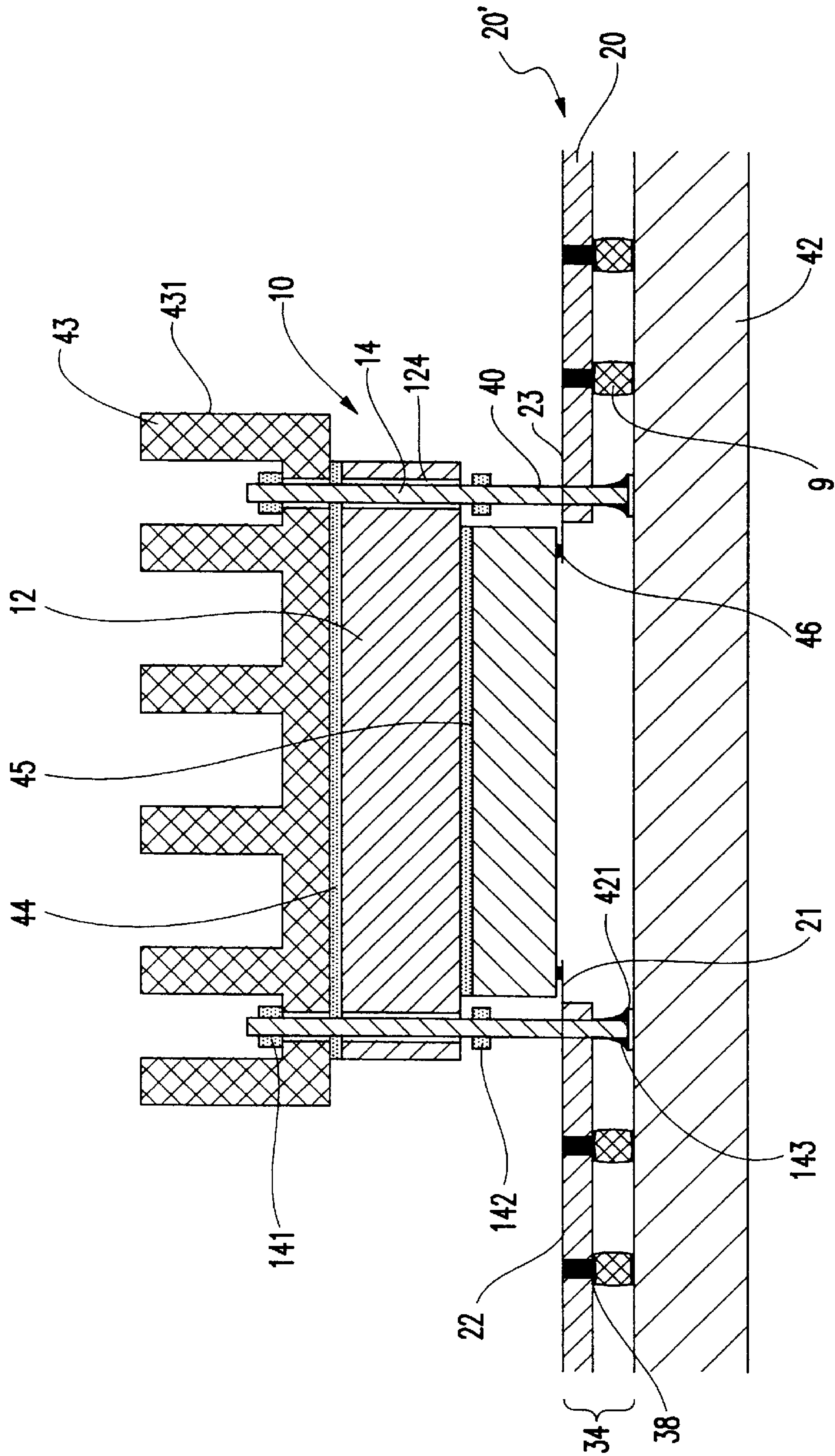


FIG.5

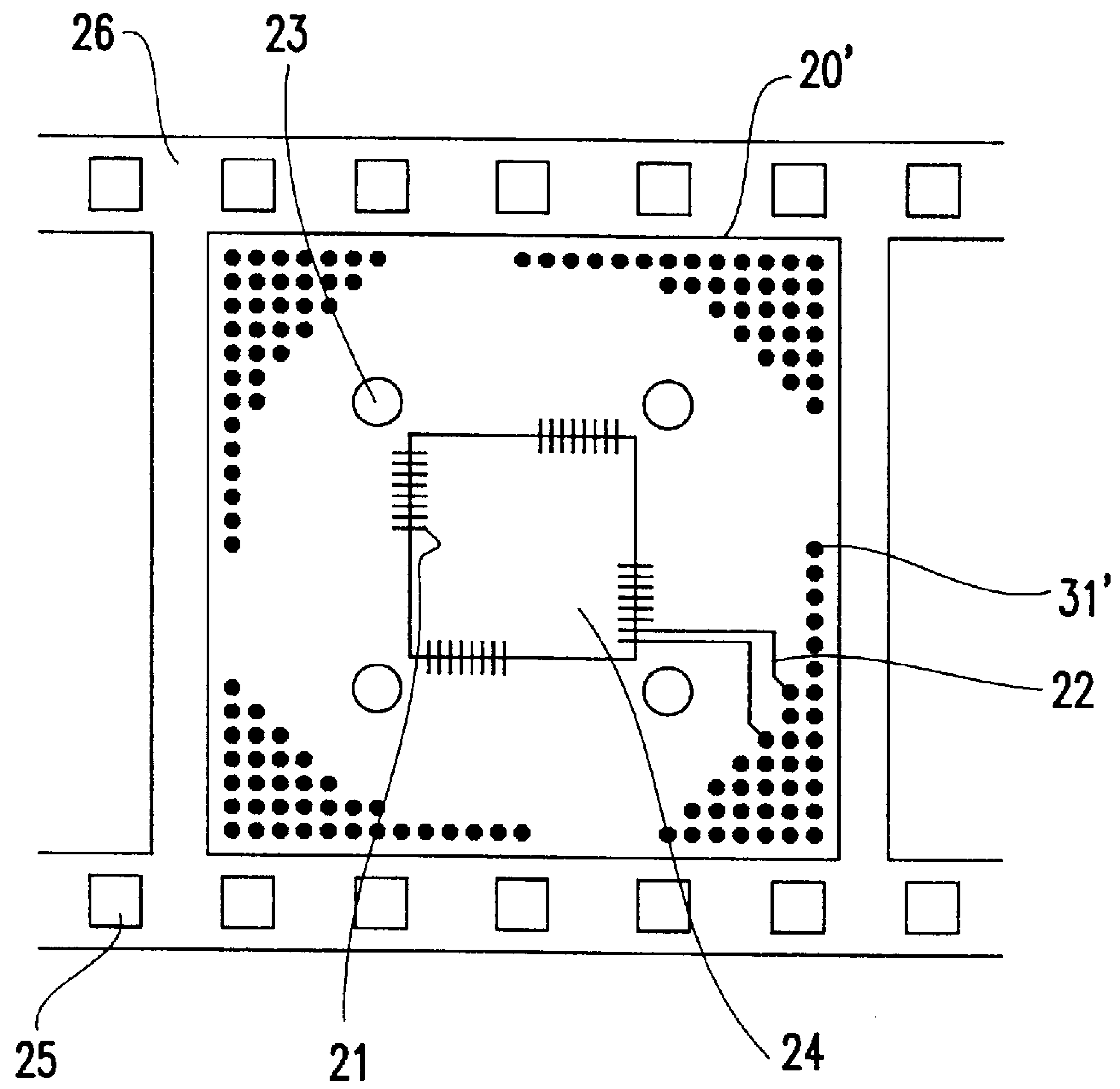


FIG.6

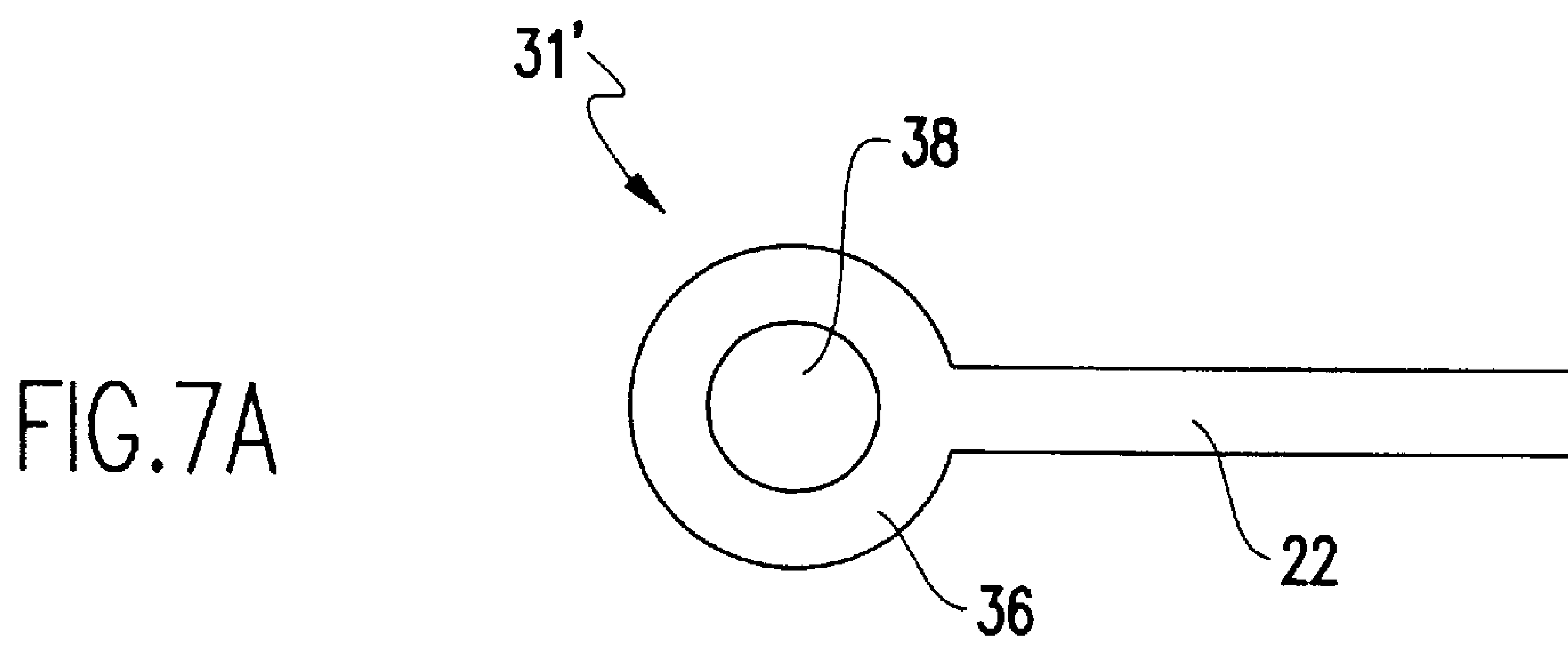


FIG.7A

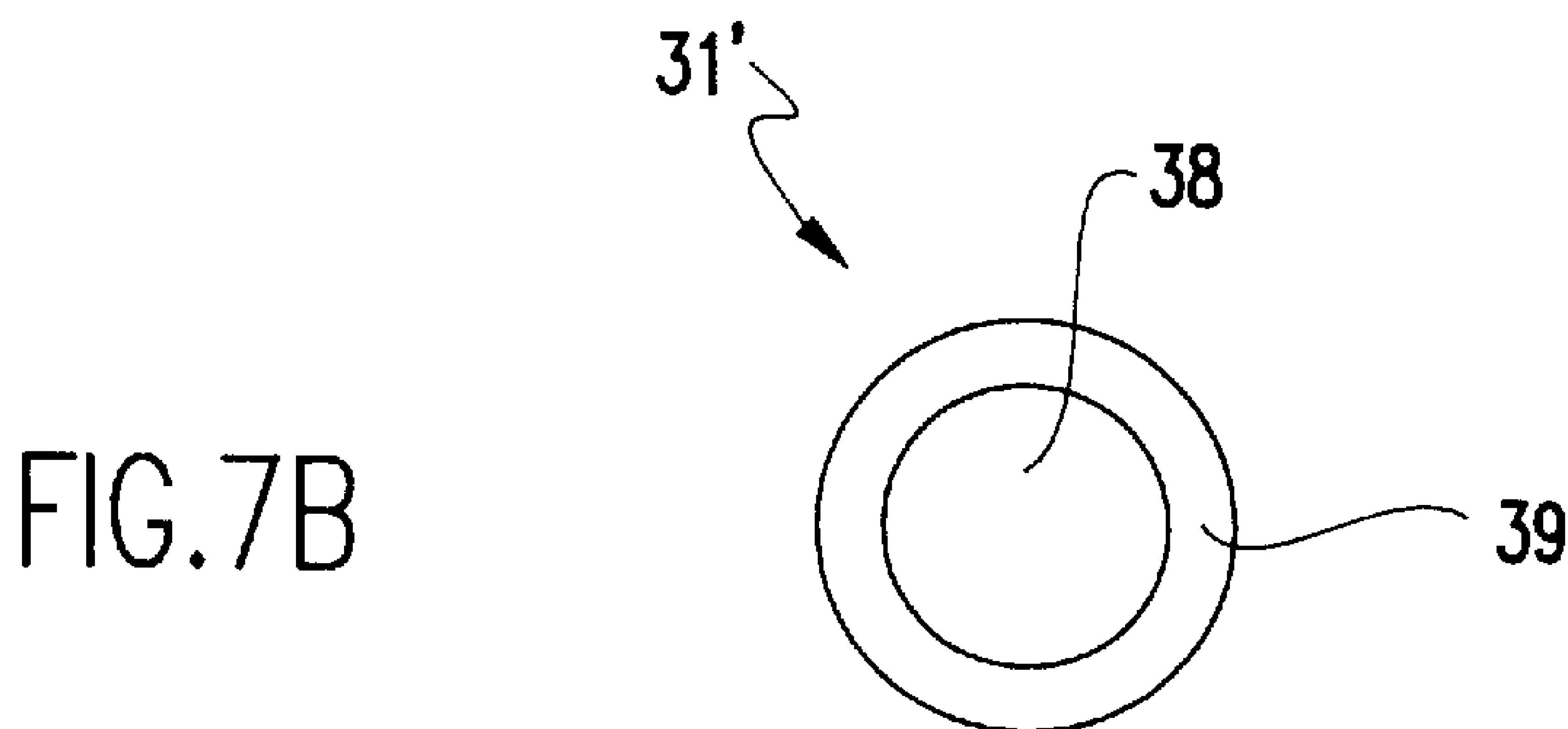


FIG.7B

FIG.8A

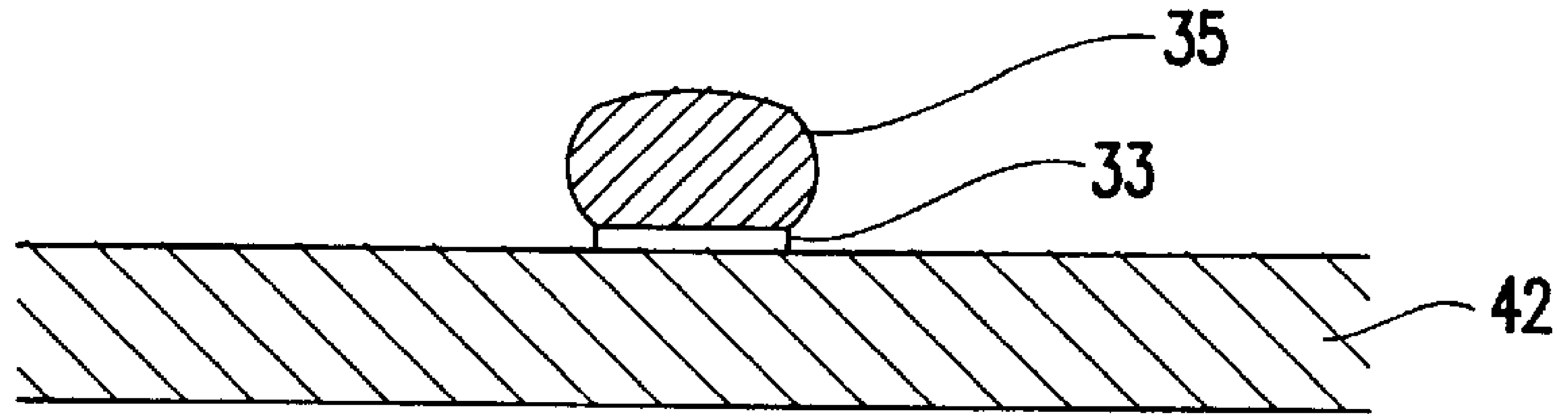


FIG.8B

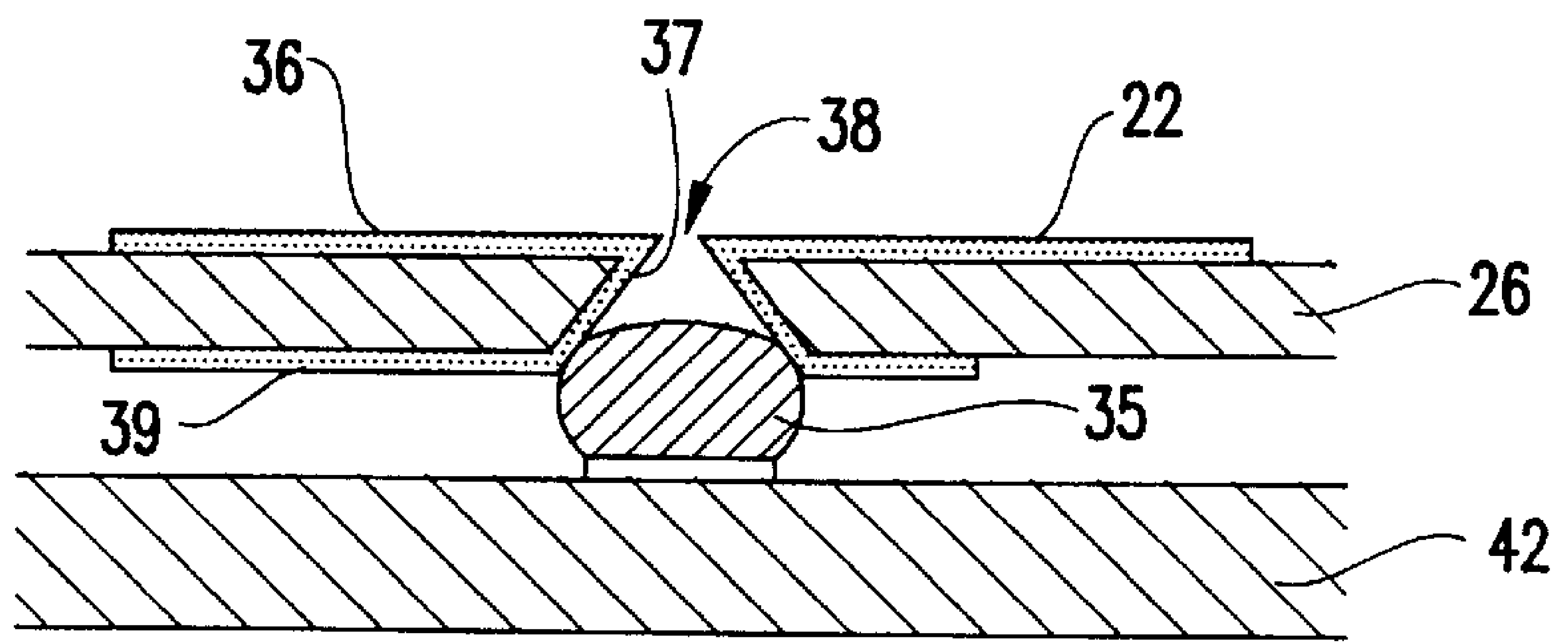
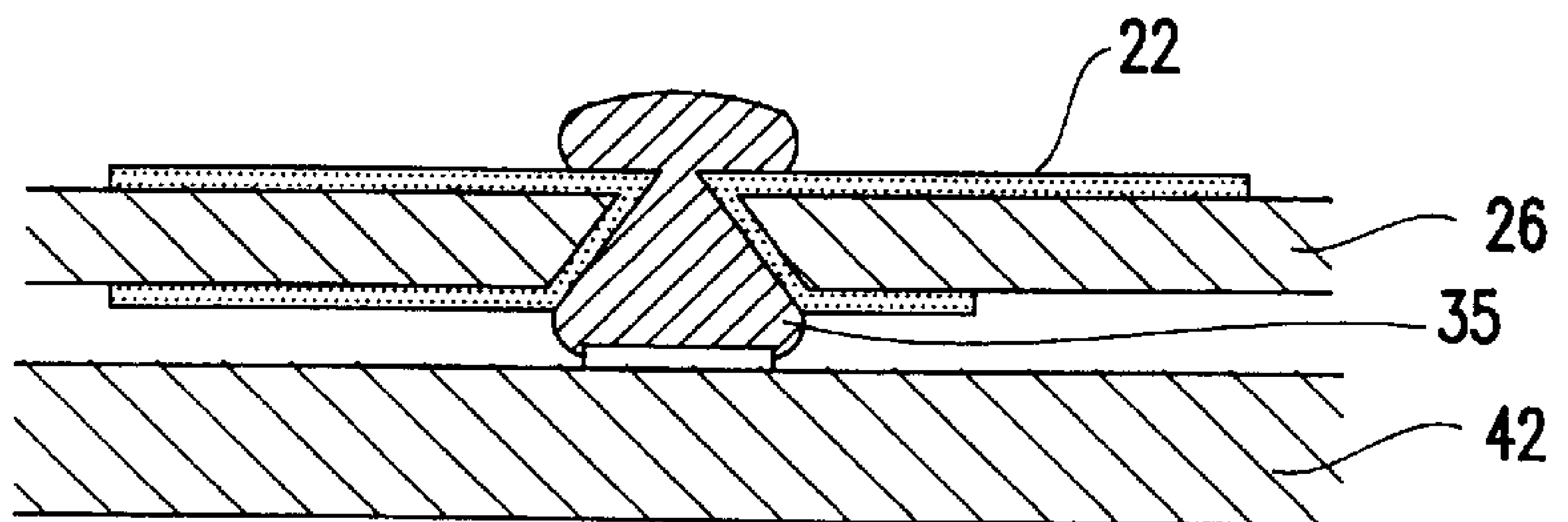


FIG.8C



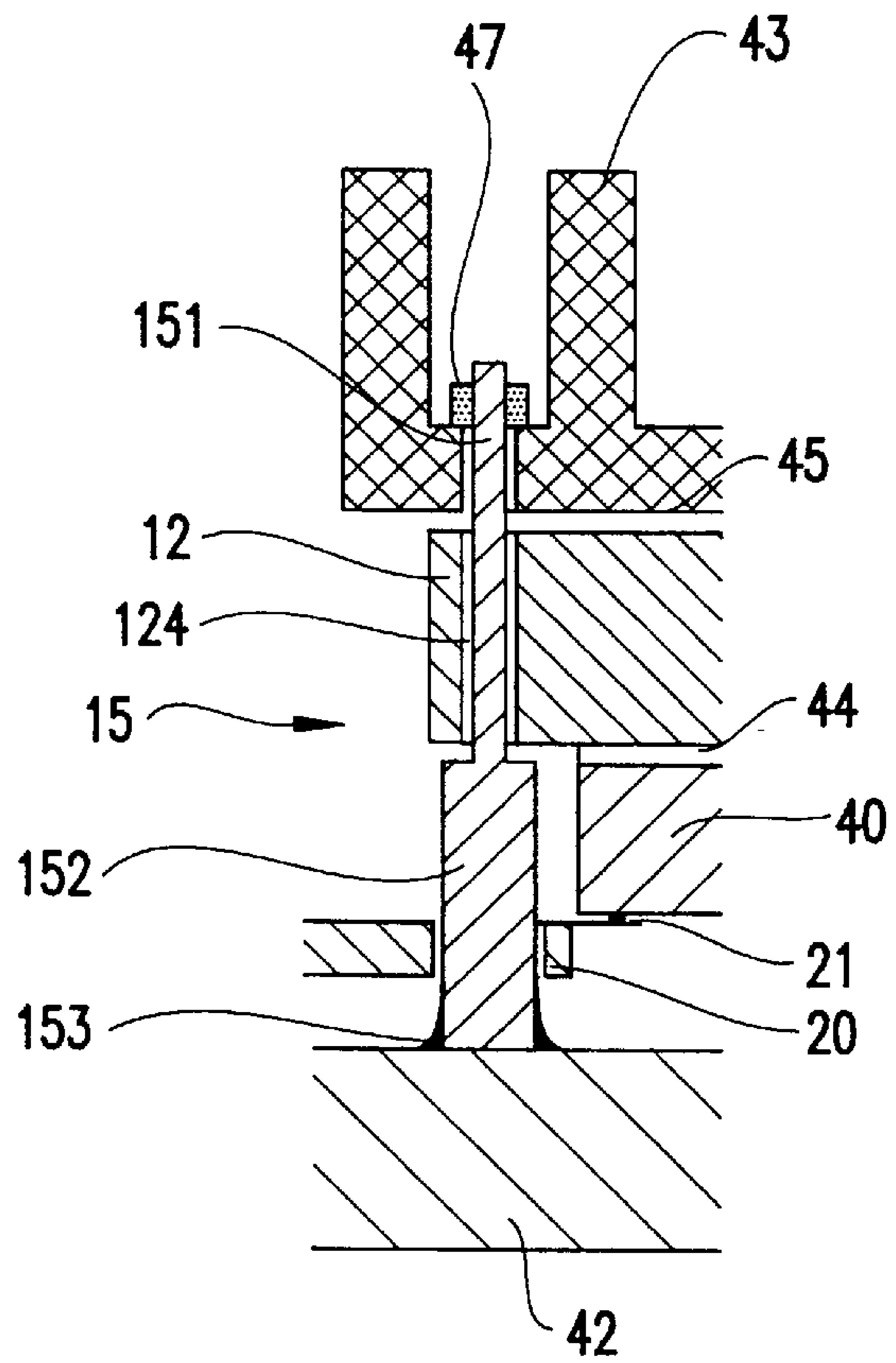


FIG.9

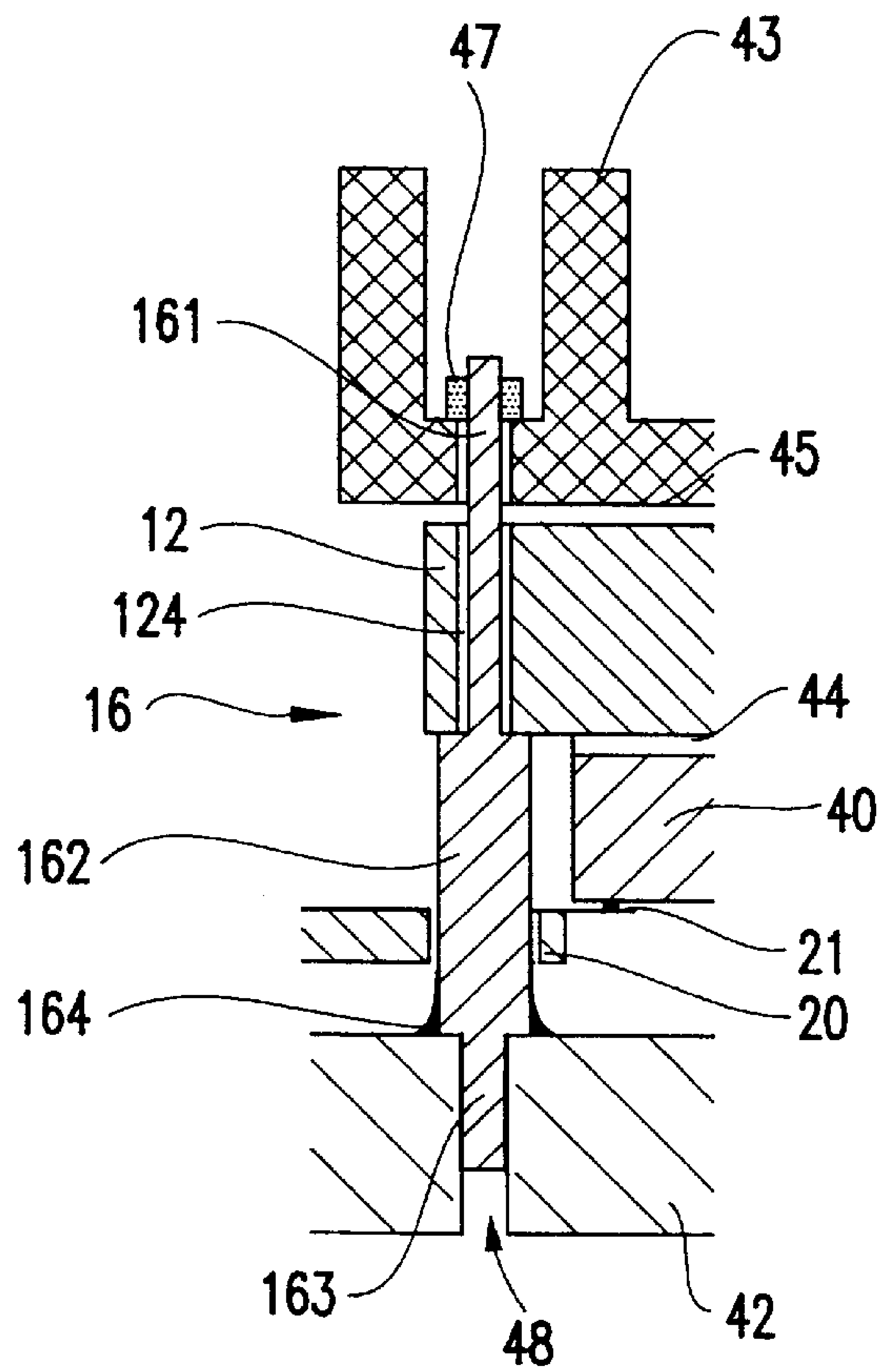


FIG.12

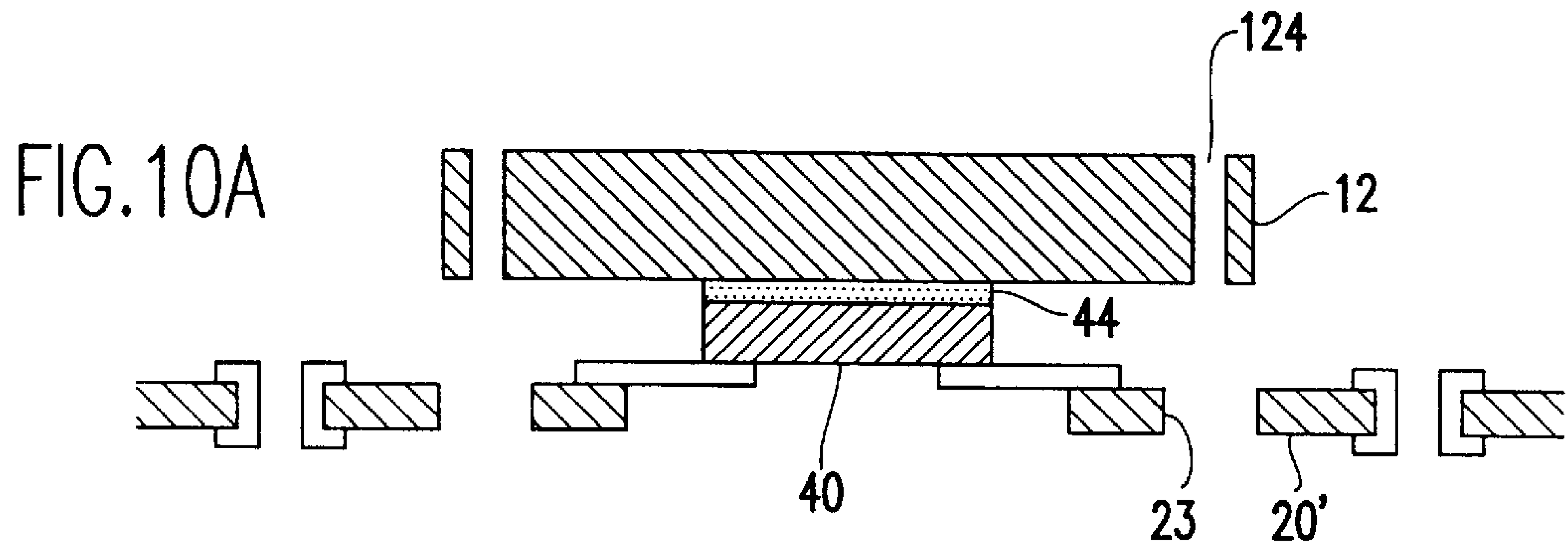


FIG.10A
124
12
44
40
23
20'

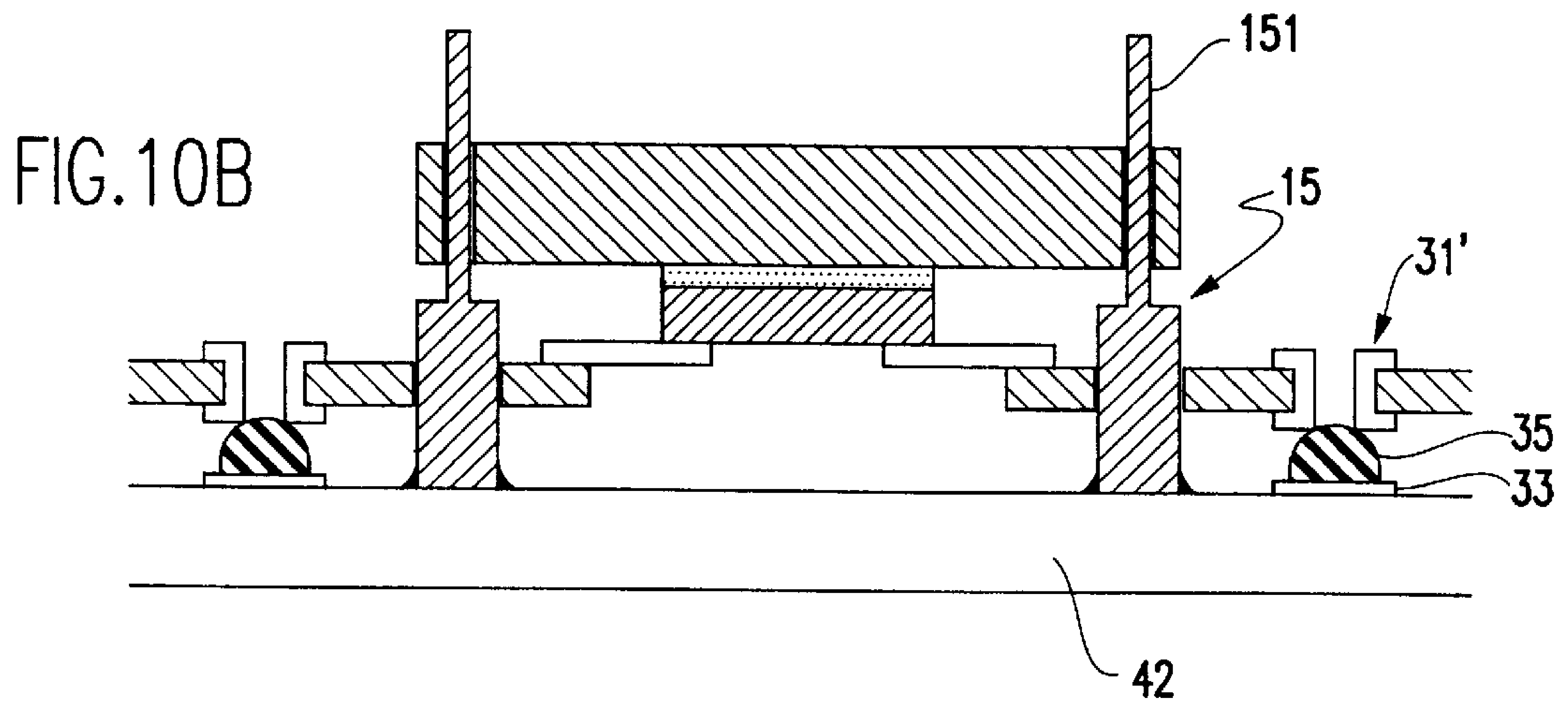


FIG.10B
151
15
31'
35
33
42

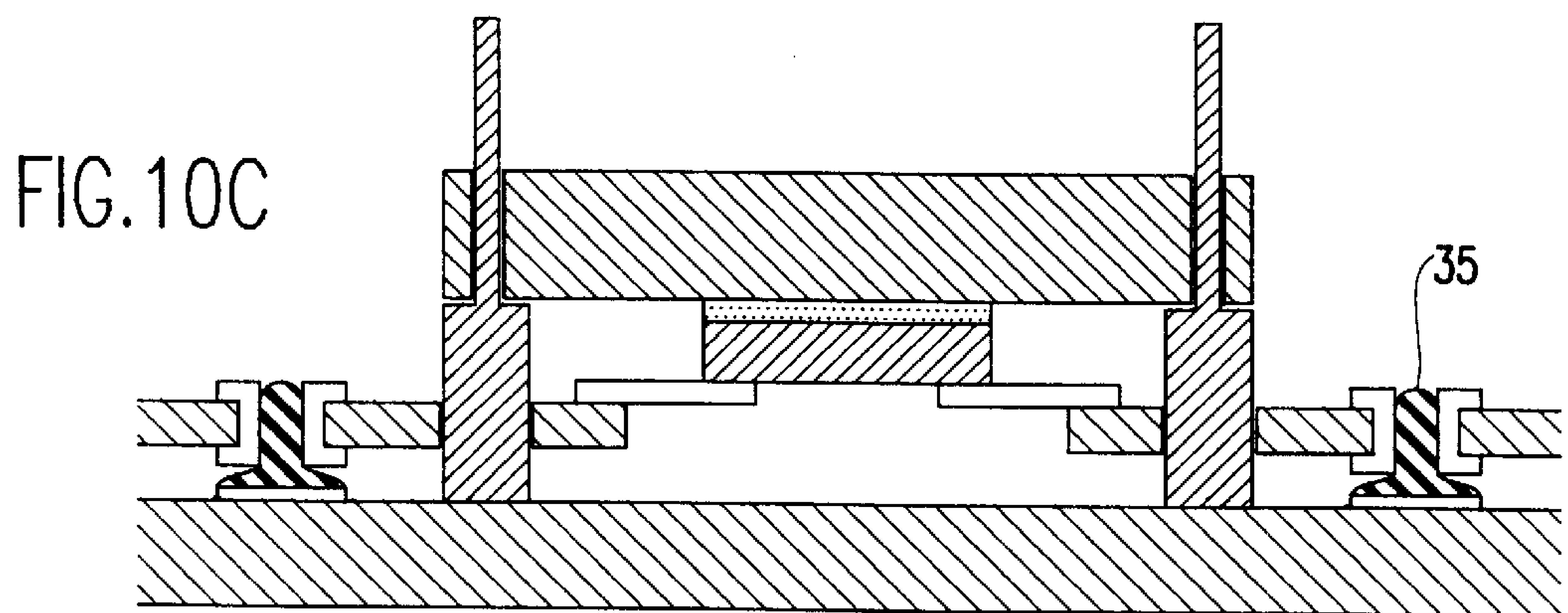


FIG.10C
35

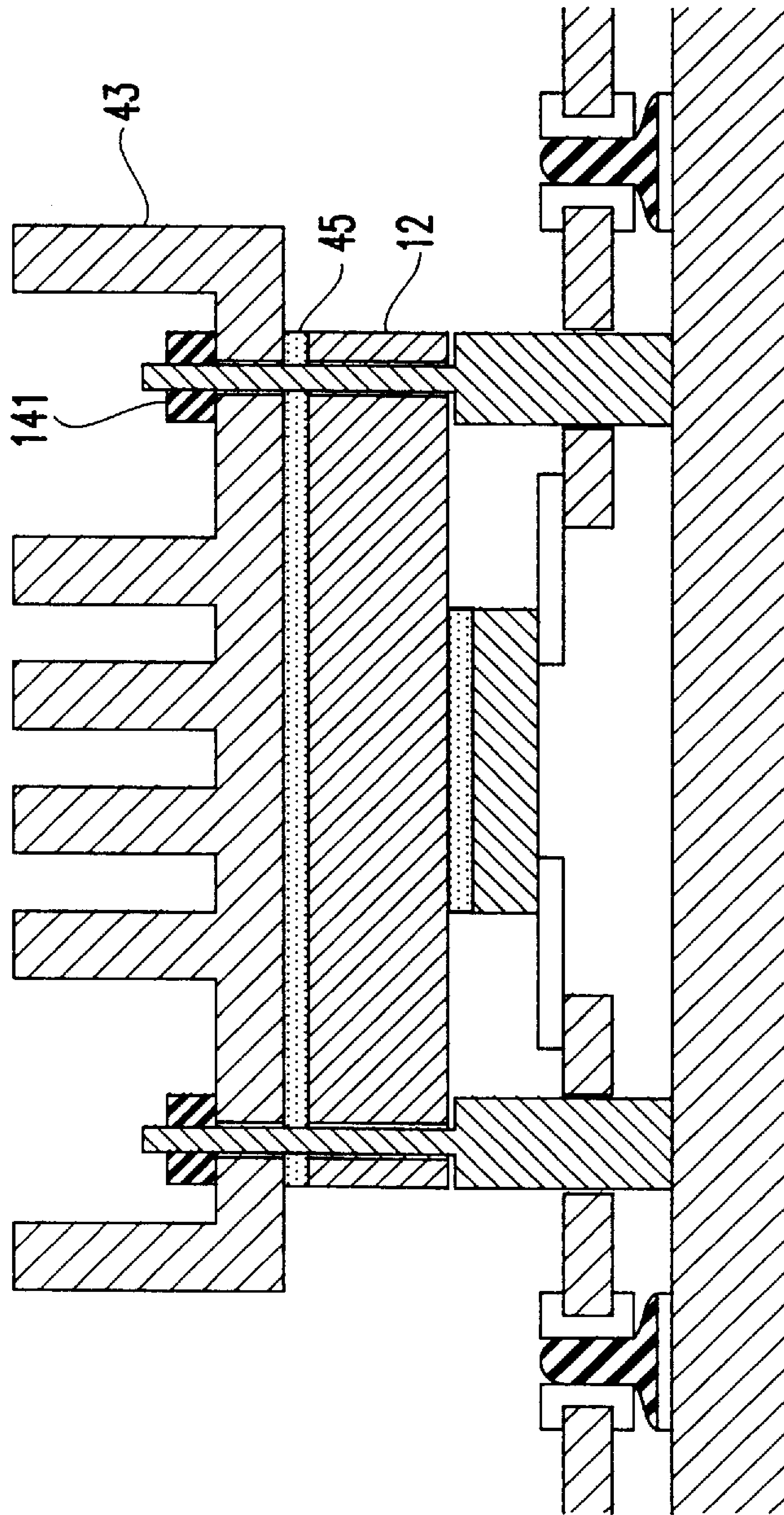


FIG.11

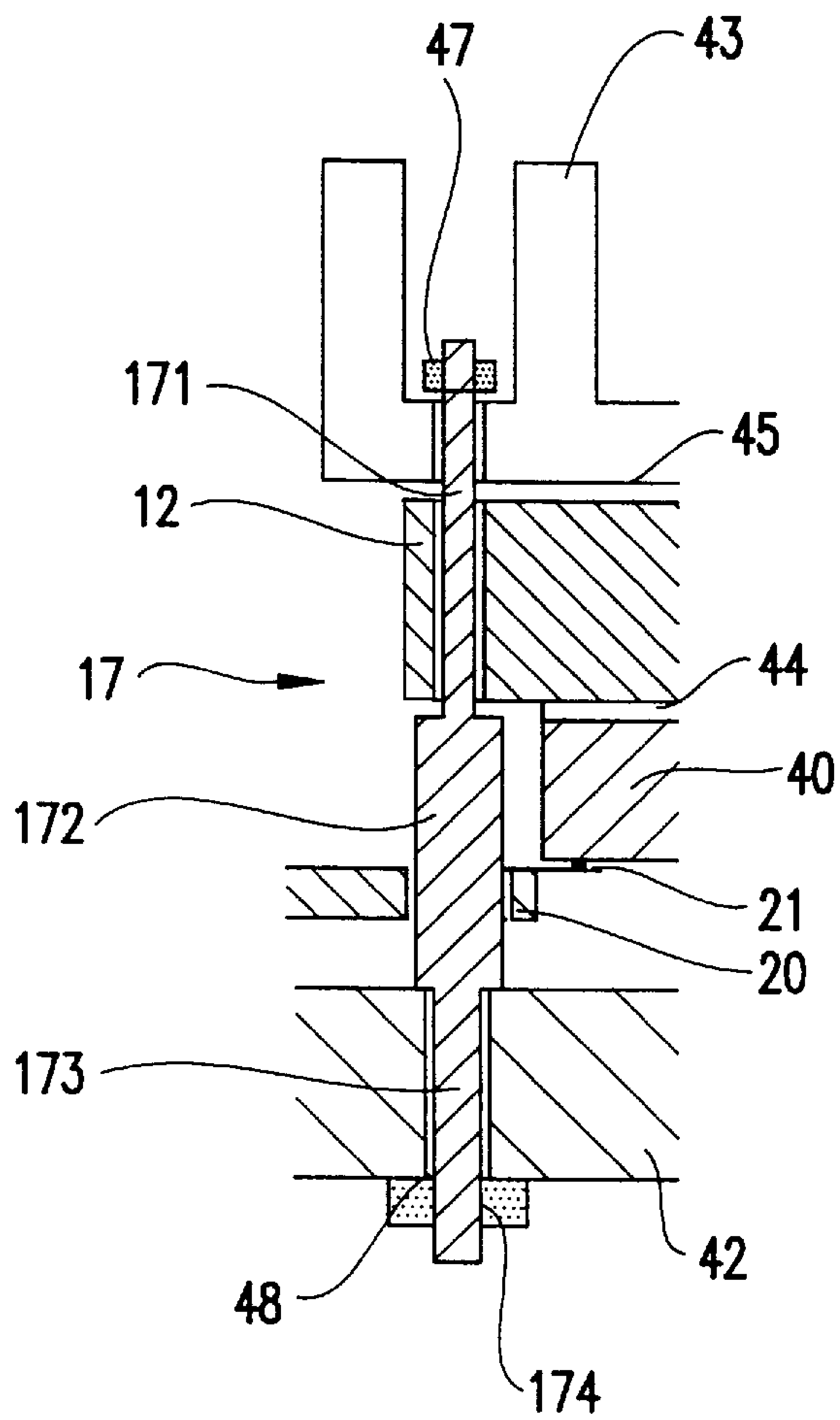


FIG.13

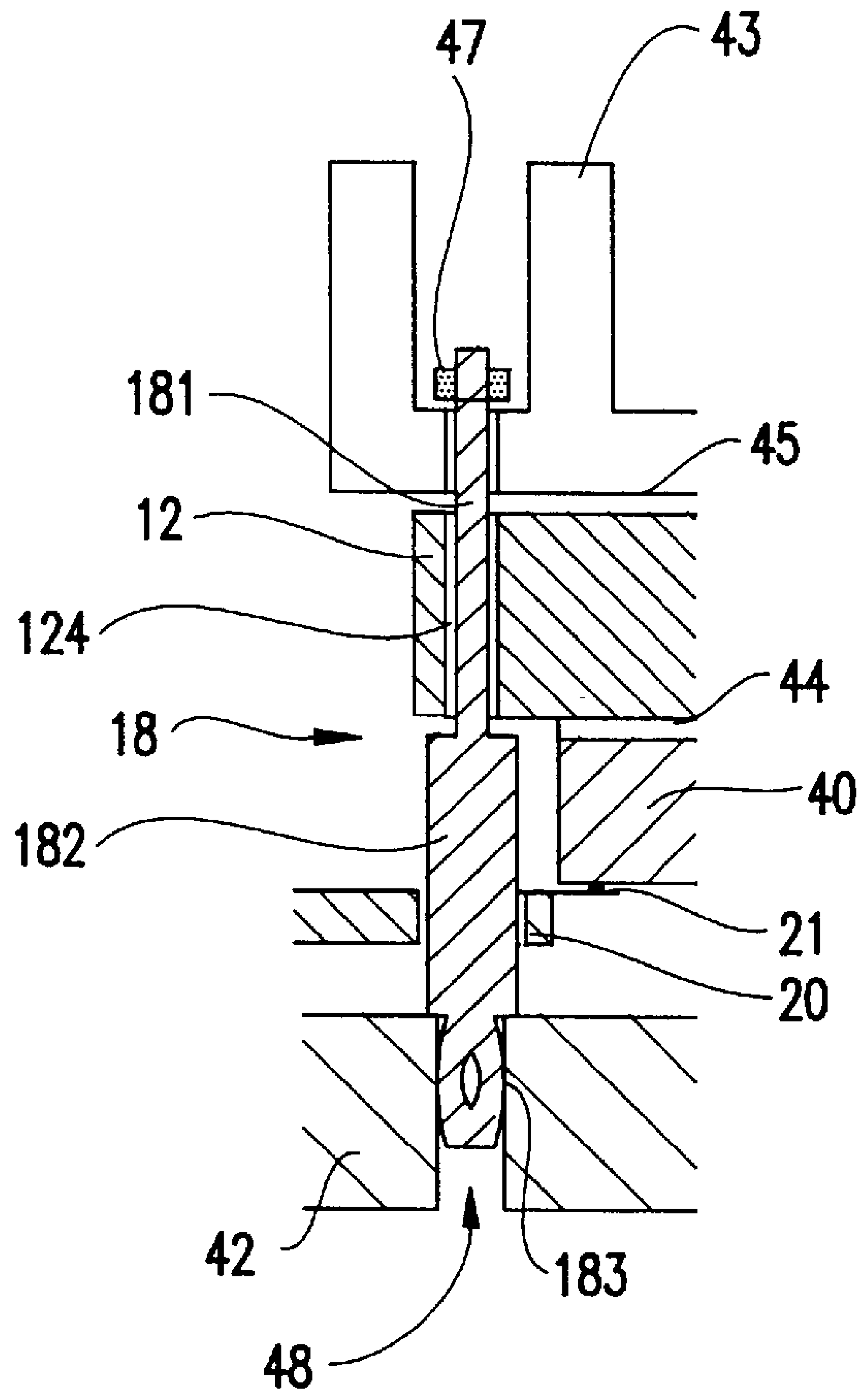


FIG.14

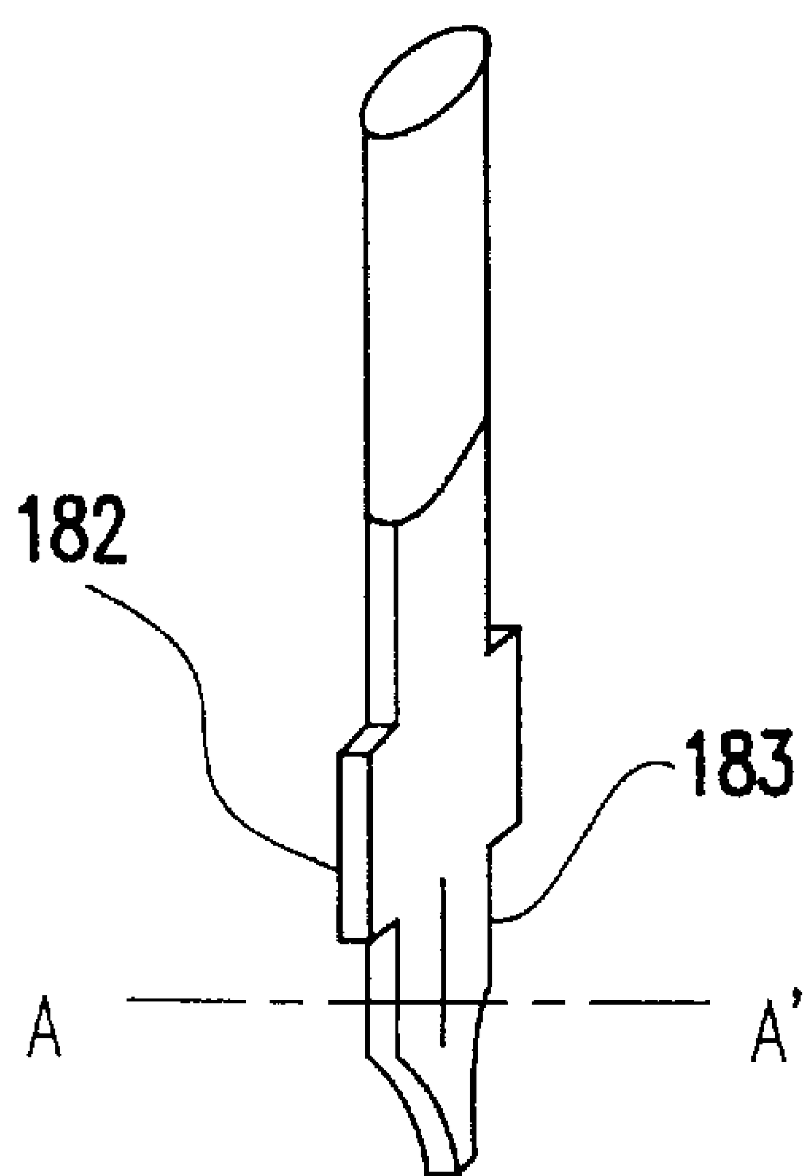


FIG.15A

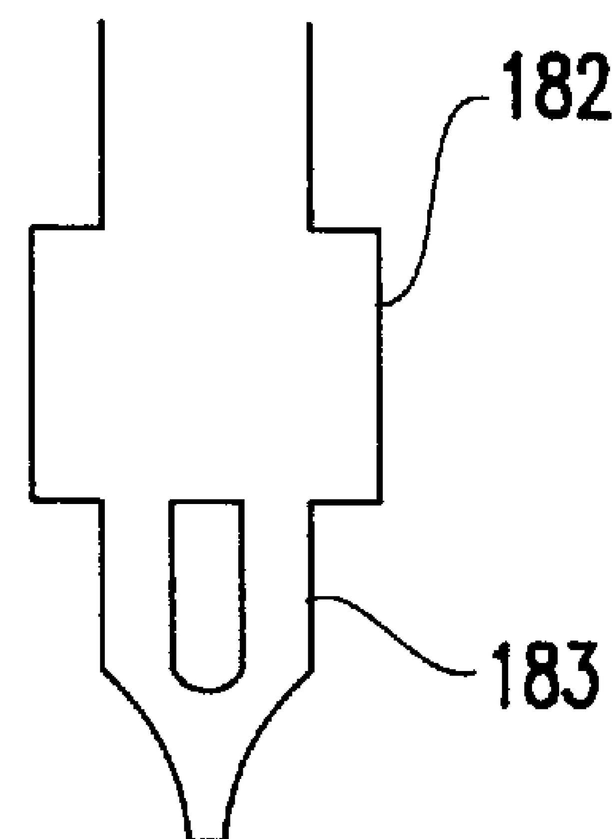


FIG.15B

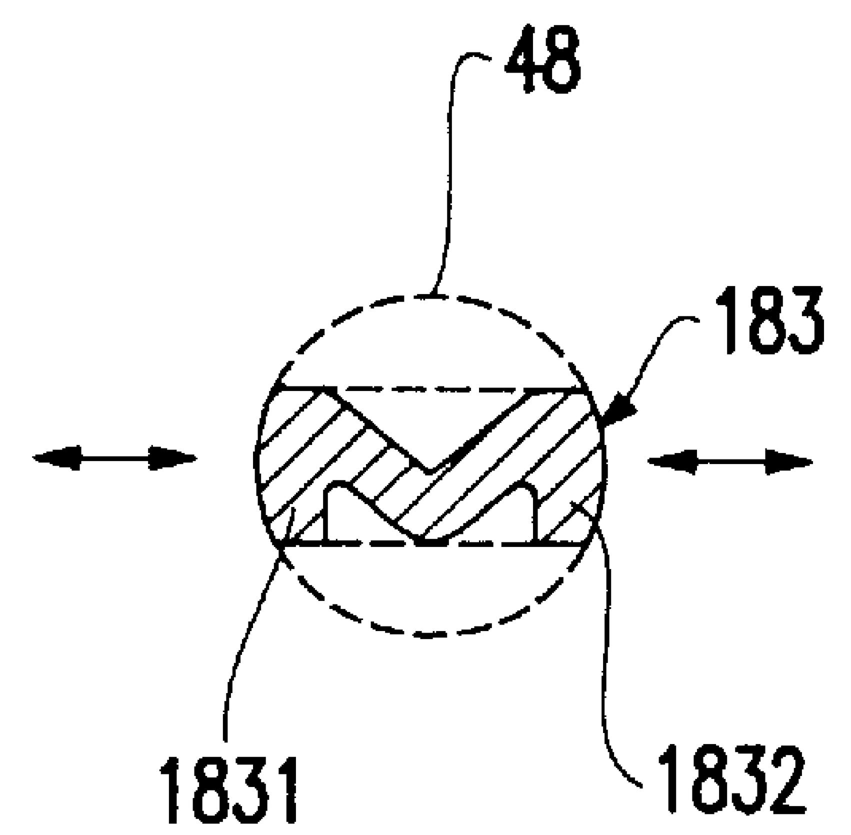


FIG.15C

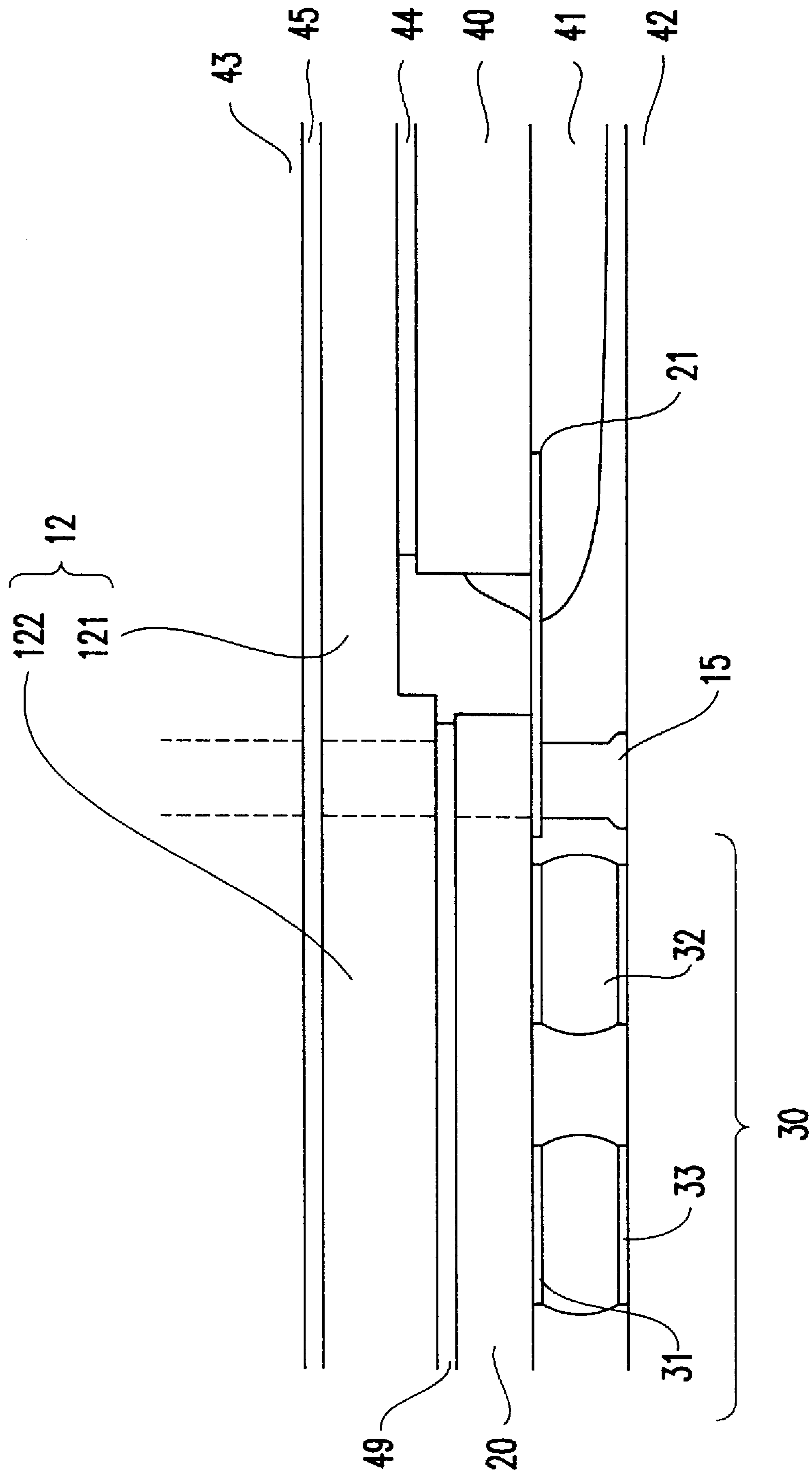


FIG. 16

FIG.17A

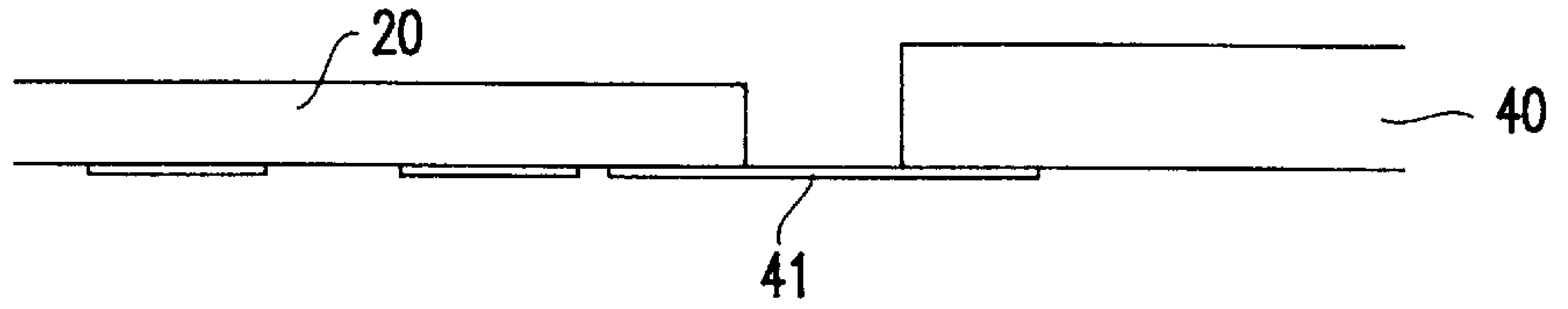


FIG.17B

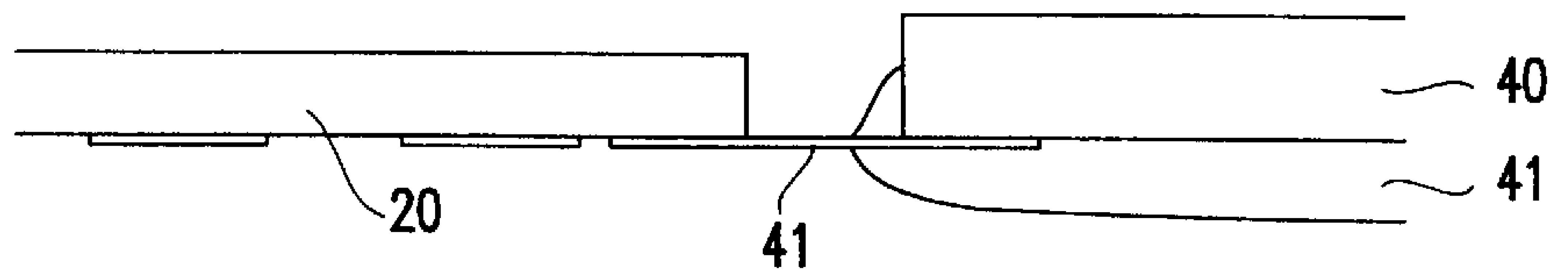


FIG.17C

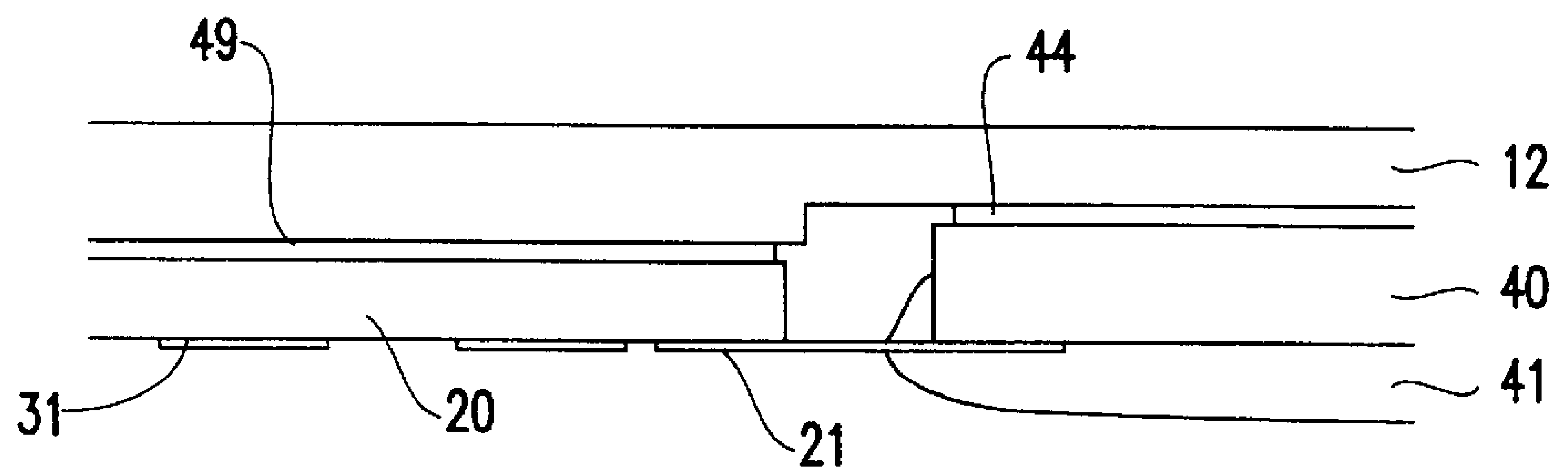


FIG.17D

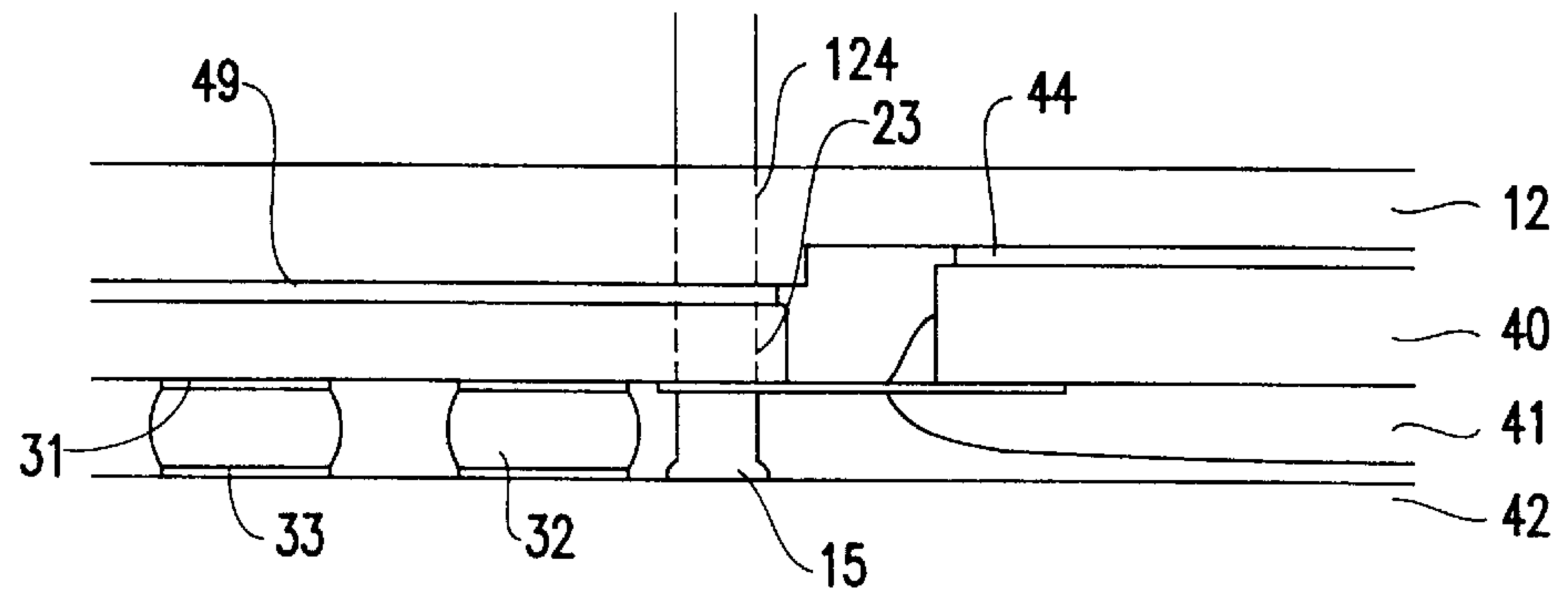
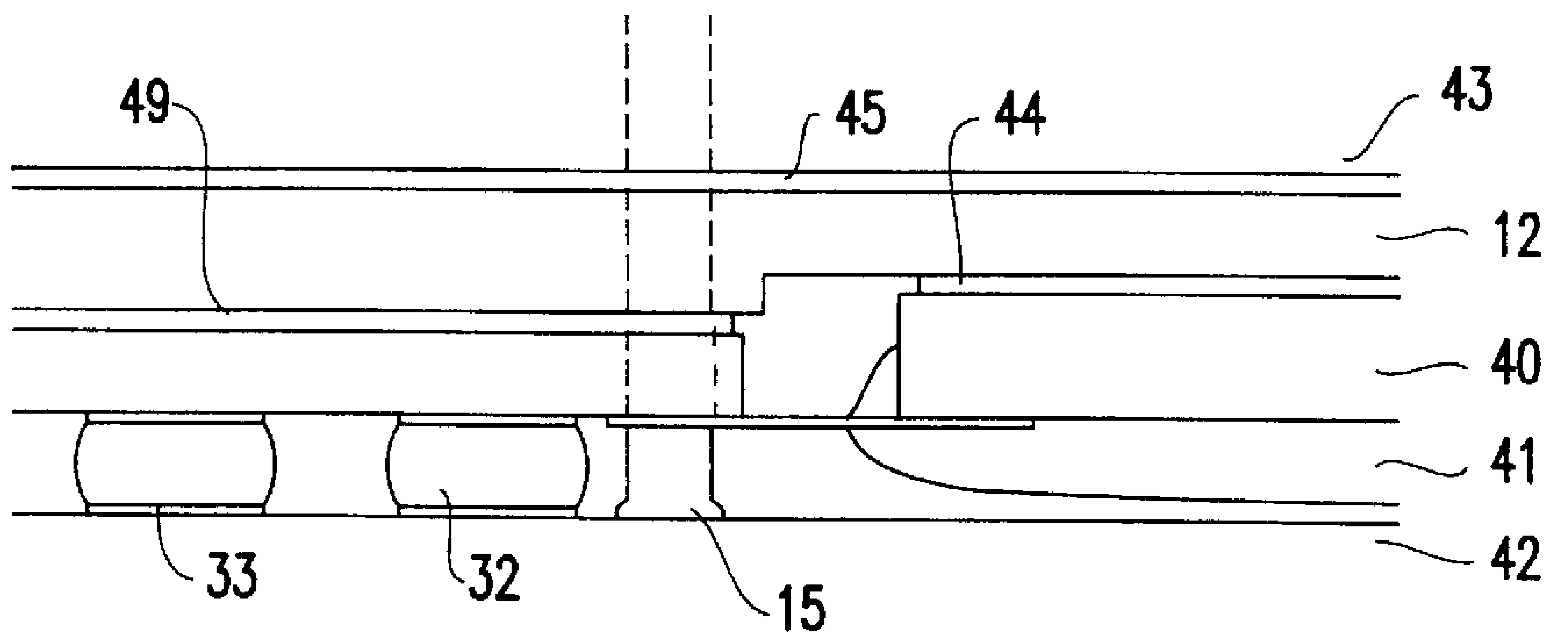


FIG.17E



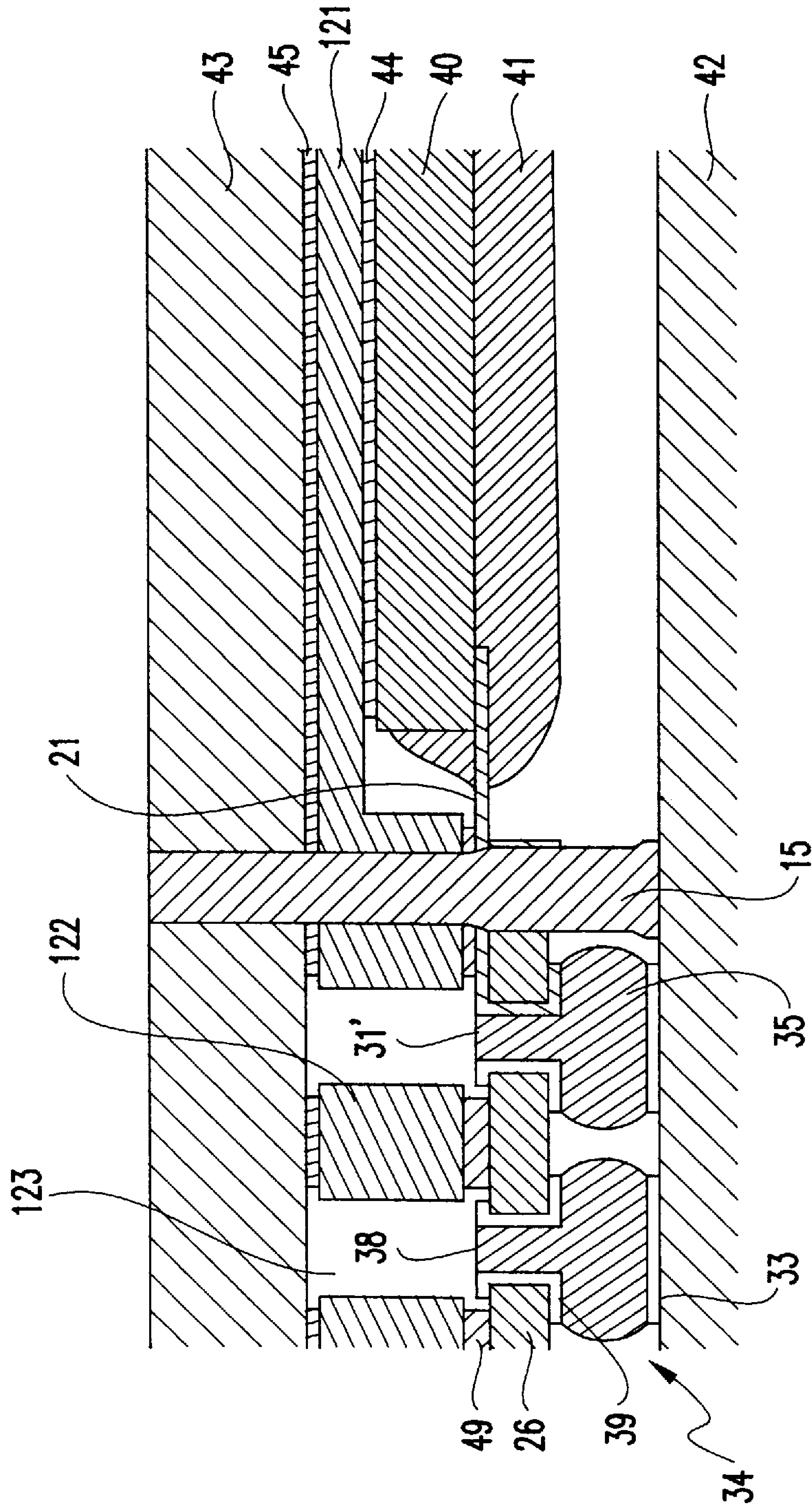


FIG. 18

SUPPORTING MEMBER FOR COOLING MEANS, ELECTRONIC PACKAGE AND METHOD OF MAKING THE SAME

This is a divisional application of application Ser. No. 08/423,455 filed Apr. 19, 1995.

BACKGROUND OF THE INVENTION

The present invention relates to a member for supporting cooling means and an electronic package using the same, and more particularly to an electronic package using the supporting member and a tape carrier.

A "tape carrier" refers to a flexible connecting structure comprising a wiring to be connected to an electronic device and an insulating film supporting the wiring. The tape carrier includes tape automated bonding (TAB) films.

An "electronic package" refers to electrical components assembled as a unit. The electronic package may, but does not necessarily, comprise a cell encapsulating the electrical components.

"Cooling means" refers to a device for absorbing and dissipating heat generated from an electric device. The cooling means may include heat sinks and/or liquid cooling modules. Examples of cooling means are disclosed in Rao R. Tummala and Eugene J. Rymaszewski, "Micro Electronics Packaging Handbook", Van Nostrand Reinhold, New York, pp.209–219.

A conventional electronic package including cooling means and a tape carrier is disclosed in FIG. 6–50 on p. 422 of the aforementioned reference.

This conventional electronic package has a heat sink as the cooling means. The heat sink is attached to the upper face of a large-scale integrated circuit (LSI). The lower face of the LSI is connected to inner leads of a tape carrier. Outer leads of the tape carrier are connected to a substrate.

Nowadays, the conventional electronic package is widely used for dissipating heat the amount of which is increased by high-density and high-speed designs of LSIs.

A conventional connecting structure between a flexible circuitized substrate and a printed substrate is disclosed in U.S. Pat. No. 5,261,155.

In this conventional connecting structure, the flexible substrate and printed substrate are connected by a solder ball provided therebetween, instead of outer leads of the flexible substrate.

However, the conventional package has the following problems.

First, the heat sink presses the LSI toward the substrate. Thus, the LSI is sandwiched between the heat sink and the substrate and may be damaged.

Secondly, the weight of the heat sink produces a mechanical stress in the tape carrier. Thus, connection between the tape carrier and the substrate may be damaged by the stress.

Thirdly, a process for assembling the conventional package must include a step of squeezing glue between the heat sink and the substrate so that the thickness of the glue becomes thin. The squeezing step is indispensable because thermal resistance between the heat sink and the LSI greatly depends on the thickness of the glue. In fact, the electronic package is set aside at room temperature for several days with the glue squeezed between the heat sink and the substrate.

Fourthly, great care must be taken for precisely positioning the terminals of the tape carrier over the corresponding terminals of the substrate. This problem is serious when the conventional connecting structure is applied in the conventional package because the terminals are obscured under the tape carrier.

The conventional connecting structure also has a problem that a faulty or failed connection is not easily detected because the solder is obscured under the flexible substrate.

SUMMARY OF THE INVENTION

In view of the above problems of the conventional package and the conventional connecting structure, an object of the present invention is to provide a supporting member for cooling means and an electronic package using the supporting member. More specifically, the supporting member frees an electronic device from being pressed by the cooling means and from being sandwiched between the cooling member and the substrate. The supporting member also frees the tape carrier from stress caused by the weight of the cooling means.

Another object of the present invention is to provide a supporting member which eliminates the step of squeezing glue between the cooling means and the supporting member.

Another object of the present invention is to provide a combination of a supporting member and a tape carrier which eliminates the need for the special attention for precise positioning of the tape carrier.

Another object of the present invention is to provide a connecting structure in which a faulty or failed connection can easily be detected.

A supporting member according to the present invention comprises a plate and a bottom leg. The plate has first and second surfaces. The cooling means is placed on the first surface of the plate. An electronic device is attached to the second surface of the plate. The bottom leg is joined to the second surface of the plate. The bottom leg may has a length greater than a thickness of the electronic device.

The aforementioned supporting means may comprise first attaching means for attaching the cooling means onto the plate. The first attaching means may comprise a threaded upper leg joined to the first surface of the plate, the upper leg being inserted into a hole provided in the cooling means, and means threaded on the upper leg for securing the cooling means.

An electronic package according to the present invention comprises a supporting member, an electronic device, a carrier and a substrate. The supporting member includes a plate and a bottom leg. The plate has first and second surfaces. The bottom leg has first and second ends. The first end of the bottom leg is joined to the second surface of the plate. The electronic device is attached to the second surface of the plate of the supporting member. The carrier has a first surface, a second surface and a hole. The second end of the bottom leg of the supporting member is inserted into the hole of the carrier. The substrate has first and second surfaces. The second end of the bottom leg is joined to the first surface of the substrate. The electronic device is positioned between the plate of the supporting member and the substrate.

The aforementioned electronic package may be assembled in the following steps. In first and second steps, the supporting member and the carrier are prepared, respectively. In a third step, the electronic device is connected to the carrier. In a fourth step, the electronic device is attached to the second surface of the plate. The second end of the bottom leg is inserted into a hole of the carrier. In a fifth step, the second end of the bottom leg is joined to the substrate.

In a sixth step, the cooling means is attached onto the first surface of the plate.

The aforementioned electronic package may comprise joining means for joining the bottom leg of the supporting member to the first surface of the substrate.

The aforementioned electronic package also may comprise attaching means for attaching the cooling means to the supporting member. The attaching means may include a fastener and a threaded upper leg having first and second ends. The first end of the upper leg is inserted into the hole provided in the cooling means. The second end of the upper leg is joined to the first surface of the plate. The fastener is threaded on the upper leg to press the cooling means to the plate.

The attaching means, the upper leg, and the bottom leg are implemented by a pin inserted in the plate. In this structure, the plate of the supporting member has a hole. The supporting member includes a pin inserted into the hole of the plate. The pin has a threaded first portion protruding from the first surface of the plate and a second portion protruding from the second surface of the plate. The first portion of the pin forms the upper leg of the supporting member. The second portion of the pin forms the bottom leg of the supporting member.

When the upper leg and the bottom leg are implemented by the pin, the electronic package may be assembled by the following steps. In first through third steps, the carrier, the plate, and the pin are prepared, respectively. In a fourth step, the second end of the pin is joined to a substrate. In a fifth step, the electronic device is attached to the second surface of the plate.

In a sixth step, the pin is inserted into the hole of the carrier and the hole of the plate. In a seventh step, the cooling means is attached onto the first surface of the plate.

The electronic package with a pin may comprise fixing means for fixing the plate to the pin.

The aforementioned electronic package also may comprise connecting means for connecting the carrier to the substrate. The connecting means may include a first pad provided on the carrier, a second pad provided on the first surface of the substrate and solder for connecting the first and second pads. The first pad may include a through-hole bored in the carrier. At least a portion of the solder is positioned in the through-hole of the first pad.

The aforementioned connecting means may be formed by the following steps. In a first step, solder is provided on the second pad of the substrate. In a second step, the first pad of the carrier is positioned on the solder. In a third step, the solder is heated to flow the solder into the through-hole of the carrier.

In the aforementioned electronic package, the plate may include a first portion covering the electronic device and a second portion covering the carrier. The second portion of the plate may have a hole positioned above the first pad of the carrier.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of the present invention will become more apparent when the following description is read in conjunction with the accompanying drawings, wherein:

FIG. **1** is a perspective view of a supporting member **10** according to a first embodiment of the present invention.

FIG. **2** shows the structure of a tape carrier **20** of the first embodiment the present invention.

FIG. **3** shows the structure of an electronic package according to the first embodiment of the present invention.

FIGS. **4**(*a*)–**4**(*d*) illustrate steps of the assembling process of the electronic package shown in FIG. **3**.

FIG. **5** shows the structure of an electronic package according to a second embodiment of the present invention.

FIG. **6** shows the structure of a tape carrier **20'** of the second embodiment of the present invention.

FIGS. **7**(*a*) and **7**(*b*) show the detailed structure of a pad **31'** shown in FIG. **6**.

FIGS. **8**(*a*)–**8**(*c*) illustrate steps of a process for connecting the pad **31'** of the tape carrier **20** and a pad **33** of a substrate **42**.

FIG. **9** shows the structure of an electronic package according to a third embodiment of the present invention.

FIGS. **10**(*a*)–**10**(*c*) illustrate steps of the assembling process of the electronic package shown in FIG. **9**.

FIG. **11** illustrates a step of the assembling process of the electronic package shown in FIG. **9**.

FIG. **12** shows the structure of an electronic package according to a fourth embodiment of the present invention.

FIG. **13** shows the structure of an electronic package according to a fifth embodiment of the present invention.

FIG. **14** shows the structure of an electronic package according to a sixth embodiment of the present invention.

FIGS. **15**(*a*)–**15**(*c*) show the detailed structure of a pin **18** shown in FIG. **14**.

FIG. **16** shows the structure of an electronic package according to a seventh embodiment of the present invention.

FIGS. **17**(*a*)–**17**(*e*) show steps of the assembling process of the electronic package shown in FIG. **16**.

FIG. **18** shows the structure of an electronic package according to the eighth embodiment of the present invention.

In these drawings, the same reference numerals depict the same parts, respectively.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Next is described the structure of a supporting member **10** according to the first embodiment of the present invention.

Referring to FIG. **1**, supporting member **10** comprises a square plate **12** whose sides and thickness are about 22 mm and 1–2 mm, respectively. The plate **12** serves as a heat sink or a heat radiating plate. The plate **12** has four bottom legs **11** at each corner of its lower surface. The plate **12** also has four upper legs **13** at each corner of its upper surface.

The plate **12** is made of a material with a relatively high thermal conductivity. Specifically, the plate **12** is preferably made of a copper-tungsten alloy, whose thermal conductivity and thermal expansion coefficient are 180 W/mk and 6.5×10^{6}, respectively. Copper-Kovar alloy, Copper-Mo alloy and copper can also be used as the material of the plate **12**. Kovar is an alloy of iron, nickel and cobalt. The plate **12** can also be made of a ceramic with a relatively high thermal conductivity such as AlN.

Cooling means (e.g., a heat sink) and an electronic device (e.g., a large-scale integrated circuit) are respectively attached to the upper and lower surface of the plate **12**.

The bottom legs **11** are shaped as a cylindrical column whose diameter and height are approximately 1.6–1.7 mm and 0.8 mm, respectively. The upper ends of the bottom legs **11** are connected to the lower surface of the plate **12**. The bottom legs **11** are preferably made of brass. The height of the bottom legs **11** is set so that the electronic device is not

pressed against a substrate by the cooling means when the supporting member **10** is placed on the substrate. Preferably, the height of the bottom legs **11** is greater than the thickness of the electronic device.

The upper legs **13** are shaped as a cylindrical column whose diameter and height are approximately 1.0 mm and 4.0 mm, respectively. The lower ends of the upper legs **13** are connected to the upper surface of the plate **12**. The upper legs **13** are preferably made of brass. The upper portion of the upper leg **13** is threaded.

The supporting member **10** may be prepared by the following methods. A first method includes cutting a material body to form the bottom legs **11**, plate **12**, and the upper legs **13**. A second method includes soldering the upper legs **13** and the bottom legs **11** to the plate **12**. A third method includes boring through-holes in the plate **12** and inserting pins into the thorough-holes. Then, the pins are soldered to the plate **12**. The portion of the pin protruding from the upper and lower faces of the plate **12** serves as the upper legs **13** and bottom legs **11**, respectively.

Referring to FIG. **2**, a tape carrier **20** which is used with the supporting member **10** includes a film **26**.

The thickness of the film **26** is about 50 μm. The film **26** is made of an organic insulating resin with heat resistance and a low thermal expansion coefficient. The film **26** is preferably made of a material which is easily attachable to wirings **22** thereonto. Specifically, the film **26** is made of a polyimide. Fluororesins and epoxy resins can also be used as the material of the film **26**.

The film **26** has circular holes **23** for receiving the bottom legs **11** of the supporting member **10**. The holes **23** are shaped so as to fit to the bottom legs **11**. In the first embodiment, the diameter of the holes **23** is 1.8 mm.

The film **26** has a device hole **24** for receiving an electronic device (e.g., an LSI). In this exemplary embodiment, the device hole **24** is shaped as a square whose side is about 18.0 mm. However, the hole **24** can be formed to have any shape so as to correspond to the shape of the LSI.

The tape carrier **20** has inner leads **21** protruding into the device hole **24**. In the exemplary embodiment, the number of the inner leads **21** is about 800. The inner leads **21** are aligned with an 80 μm pitch. The inner leads **21** are connected to pads **31** via the wirings **21**. The pads **31** are disposed in a grid pattern. The inner leads **21**, the wirings **22**, and the pads **31** are formed on the lower surface of the tape carrier **20**.

The tape carriers **20** of the first embodiment are formed in a tape automated bonding (TAB) tape which includes sequentially provided tape carriers **20**. Each tape carrier **20** occupies an area of 43 mm×43 mm. Holes **25** are formed along both sides of the TAB tape. The tape carriers **20** are moved by rotating a sprocket wheel by fitting the teeth of the sprocket wheel into the holes **25**.

Referring to FIG. **3**, an electronic package using the supporting member **10** includes LSI chip **40** of 17.5 mm×17.5 mm. An integrated circuit is formed in the lower surface of the LSI **40**. The LSI chip **40** has about 800 input/output terminals (not shown) on the lower surface thereof. The terminals are aligned with about an 80 μm pitch. The terminals of the LSI chip **40** are connected to the inner leads **21** of the tape carrier **20**. The LSI chip **40** is received into the device hole **24** of the tape carrier **20**. The lower surface of the LSI chip **40** and the inner leads **21** of the tape carrier **20** are encapsulated in a resin **41**.

The bottom legs **11** of the supporting member **10** are inserted into the holes **23** of the tape carrier **20**. The upper

surface of the LSI chip **40** is attached (e.g., glued) to the lower face of the plate **12** of the supporting member **10** by an adhesive **44**. The adhesive **44** is preferably an epoxy-type adhesive including silver powder as a filler. Au/Sn-type solders can be used as the adhesive **44** instead of resins. When the LSI chip **40** is attached by a solder, a layer of Ti/Au or Ni is formed on the upper of the LSI chip **40** and the lower face of the plate **12**.

The bottom legs **11** are connected (e.g., soldered by solder **111**) to pads **421** on a substrate **42**. Any type of substrate can be used as the substrate **42**. Among the substrates used as the substrate **42** are glass epoxy substrates, polyimide substrates, and ceramic substrates.

Pads **33** are formed on the upper face of the substrate **42**. The pads **33** are connected to the pads **31** of the tape carrier **20** via solder bumps **32**. The pads **31**, the solder bumps **32**, and the pads **33** form a connecting structure **30**.

A heat sink **43** is attached to the upper face of the plate **12** of the supporting member **10**. The upper legs **13** of the supporting member **10** are inserted into holes **431** bored in the heat sink **43**. The threaded upper portions of the upper legs **13** protrude through the upper face of the heat sink **43**. Suitable fasteners (e.g., nuts) **47** are screwed onto the upper portion of the upper legs **13** to secure the heat sink **43** to the supporting member **10**. A silicone-type adhesive **45** is provided between the lower face of the heat sink **43** and the upper face of the plate **12** of the supporting member **10**.

The length between the upper surface of the LSI chip **40** and the lower surface of the resin **41** is about 0.75 mm. Specifically, the thicknesses of the LSI chip **40** and the resin **41** are 0.45 mm and 0.3 mm, respectively. The resin **41** is kept from contacting the substrate **42**. Thus, the LSI chip **40** is not pressed against the substrate **42** by the weight of the heat sink **43**. The weight of the heat sink **43** does not produce stress in the tape carrier **20**. Further, the tape carrier **20** is not loosened or pulled off from the substrate **42** by the heat sink **43** when the substrate **42** is in an upright position.

Next is described the assembling process of the electronic package of the first embodiment.

Referring to FIG. **4**(*a*), in step 1, the terminals of the LSI chip **40** are connected to the inner leads **21** of the tape carrier **20**. Thereafter, the lower surface of the LSI chip **40** and the inner leads **21** are encapsulated in the resin **41**.

Referring to FIG. **4**(*b*), in step 2, the adhesive **44** is uniformly distributed over the upper surface of the LSI chip **40** or the lower face of the plate **12**. Thereafter, the LSI chip **40** is attached to the lower face of the plate **12** of the supporting member **10**. The bottom legs **11** of the supporting member **10** are inserted into the holes **23** of the tape carrier **20**.

Referring to FIG. **4**(*c*), in step 3, the supporting member is positioned such that the bottom legs **11** are positioned on the pads **421**. Positioning of the supporting member **10** also positions each of the pads **31** above the corresponding one of the pads **33**.

The solder bumps **32** are preformed on the pads **33** of the substrate **42**. The solder **111** is pre-applied on the pads **421** of the substrate **42**. After the positioning of the supporting member **10**, the solder bumps **32** and the solder **111** are heated to connect between the pads **31** and pads **33**, and between the bottom legs **11** and the pads **421**, respectively.

Referring to FIG. **4**(*d*), in step 4, the adhesive **45** is uniformly distributed over the upper face of the plate **12** or the lower face of the heat sink **43**. Thereafter, the heat sink **43** is positioned on the plate **12**. The upper legs **13** of the

supporting member **10** are inserted into the holes **431** (unreferenced in FIG. **4**(*d*)) of the heat sink **43**. The nuts **47** press the heat sink **43** against the plate **12** to secure the heat sink **43** on the plate **12**. The heat sink **43** squeezes the adhesive **45** to uniformly distribute and make the adhesive **45** thinner. The adhesion of the adhesive **45** takes about 24 hours and 15 minutes at room temperature and at a temperature of 150° C., respectively.

In the aforementioned assembling process, positioning of the tape carrier **20** as in the conventional processes is unnecessary because the positioning of the supporting member **10** simultaneously and precisely positions the tape carrier **20** into a predetermined position.

Further, aforementioned assembling process does not include a step for squeezing the adhesive **45** because the nuts **47** press the heat sink **43** against the plate **12** to thereby squeeze the adhesive **45**.

Next is described the second embodiment of the present invention. The second embodiment has several features. A first feature is forming the bottom legs **11** and upper legs **13** of the supporting member **10** by inserting pins into the plate **12**. Another feature is adopting a novel connecting structure for the connection between the tape carrier **20** and the substrate **42**.

Referring to FIG. **5**, a, supporting member **10** of the second embodiment includes four pins **14**. The pins **14** are shaped as cylindrical columns whose diameter is approximately 1.0 mm. The pins **14** are preferably made of brass or Kovar. The pins **14** are preferably plated with nickel. The lower ends of the pins **14** are connected (e.g., soldered by the solder **143**) to the pads **421** on the substrate **42**. The solder **143** is preferably Sn 63 wt. %–Pb 37 wt % eutectic solder. The pins **14** are threaded to receive nuts **142**.

The LSI **40** is connected to the inner leads **21** of the tape carrier **20'**. The pins **14** are inserted into the holes **23** of the tape carrier **20'**. The tape carrier **20'** is connected to the substrate **42** via a connecting structure **34**. The detailed structures of the tape carrier **20'** and the connecting structure **34** are described below.

The size of the plate **12** is preset so that the plate **12** does not cover the connecting structure **34**. In the second embodiment, the plate **12** is preferably a square whose sides and thickness are approximately 22 mm and 1–2 mm, respectively. The plate **12** has through-holes **124** at each corner. The pins **14** are inserted into the holes **124**. The plate **12** is supported by the nuts **142**. The LSI chip **40** is attached (e.g., glued) to the lower face of the plate **12**.

The heat sink **43** is attached (e.g., glued) to the upper face of the plate **12**. The upper portions of the pins **14** are inserted into the holes **431** of the heat sink **43**. The heat sink **43** is secured by the nuts **141**. The plate **12** and the heat sink **43** are securely held between the nuts **142** and the nuts **141**.

The material of the plate **12** is the same as that of the first embodiment.

Next is described the structure of the tape carrier **20'** and the connecting structure **34**.

Referring to FIG. **6**, the inner leads **21** and the wirings **22** are formed on the upper surface of the tape carrier **20'**. One end of each of the wirings **22** is connected to one of the inner leads **21**. The other end of each of the wirings **22** is connected to one of the pads **31'**.

The wirings are preferably made of copper plated with gold. The width and the thickness of the wirings are approximately 40 cm and 10–25 μm, respectively. The pads **31'** are disposed in a grid pattern with approximately a 1.27 mm pitch. The detailed structure of the pads **31'** is described below.

In the second embodiment, the diameter of the holes **23** of the tape carrier **20'** is set to approximately 1.1 mm to match the pins **14**. The material of the film **26** and the size of the device hole **24** are the same as those of the first embodiment.

5 Next is described the structure of the pads **31'**.

Referring to FIGS. **7**(*a*) and **7**(*b*), each of the pads **31'** includes annular conductor patterns **36** and **39** on the upper and lower surface of the tape carrier **20'**, respectively. The outer diameters of the conductor patterns **36** and **39** are 10 approximately 250 μm and 600 μm, respectively. The wirings **22** are connected to the conductor pattern **36**.

Referring to FIG. **8**(*b*), each of the pads **31'** further includes a through-hole **38** which is formed in the film **26**. The diameter of the through-hole **38** is set to approximately 15 150 μm and 300 μm at the upper and lower surfaces of the film **26**, respectively, thereby tapering the through-hole **38**. The advantages of such a tapered through-hole **38** are described below. Another conductor pattern **37** is formed on the inner surface of the through-hole **38**. The conductor 20 pattern **37** connects the conductor patterns **36** and **39**.

The conductor patterns **36**, **37**, and **39** are preferably made of copper plated with gold. The thickness of the conductor patterns is approximately 20 μm.

Next is described the process for connecting the pads **31'** 25 of the tape carrier **20'** and the pads **33** of the substrate **42**.

Referring to FIG. **8**(*a*), in step 1, solder **35** is applied onto the pads **33** of the substrate **42**. The solder **35** is preferably Sn 63 wt %–Pb 37 wt % eutectic solder. The height and the volume of the solder **35** are approximately 300 μm and 30 0.6×10^{-10}m^3, respectively.

Referring to FIG. **8**(*b*), in step 2, the pad **31'** of the tape carrier **20'** is positioned above the pad **33** of the substrate **42**.

Referring to FIG. **8**(*c*), in step 3, the solder **35** is heated 35 to approximately 200° C.–250° C. By heating, the solder **35** melts to travel or flow upwardly into the through-hole **38** by channeling. The solder **35** that thus flows appears on the upper surface of the tape carrier **20'** and is readily observable.

40 Next is described how a faulty or failed connection of the connecting structure **34** is detected. If the solder **35** appears on the upper surface of the tape carrier **20'**, the connection is determined to be completed. However, if the solder **35** is absent, the connection may be faulty or completely failed. 45 Thus, the connection failure in the connecting structure **34** can be detected easily since the lack of solder **35** on the tape carrier **20'** can be easily identified.

Thus, in addition to the features of the first embodiment, the second embodiment allows a faulty or failed connection 50 between the tape carrier **20** and the substrate **42** to be easily detected.

Next is described a third embodiment of the present invention. The feature of the third embodiment is a modification of the means for supporting the plate **12**. Other 55 structures and functions of the third embodiment are the same or similar to those of the first embodiment.

Referring to FIG. **9**, in the third embodiment, each of pins **15** have first and second portions. The diameters of the first portion **151** and the second portion **152** are approximately 60 1.0 mm and 1.6 mm, respectively. The length of the second portion **152** is approximately 1.8 mm. The diameter of the holes **124** of the plate **12** and the holes **23** of the tape carrier **20'** are set to approximately 1.4 mm and 1.8 mm, respectively. The first portion **151** can be inserted into the holes 65 **124** of the plate **12**, while the second portion **152** cannot be inserted thereinto. The plate **12** is supported on the second portions **152** of the pins **15**.

The lower ends of the second portions **152** are joined to the substrate **42** by solder **153**. In the third embodiment, the substrate **42** and solder **153** are preferably a ceramic substrate and a Au—Sn type solder, respectively. The soldering of the solder **153** is performed at a temperature of approximately 350° C.

Thus, in addition to the features of the second embodiment, the third embodiment has several features. A first feature is that the nuts **142** are eliminated. Another feature is that the length of the gap between the substrate **42** and the plate **12** can be set precisely.

Next is described the assembling process of the third embodiment.

Referring to FIG. **10**(*a*), in step 1, the LSI chip **40**, which is connected to the tape carrier **20**', is attached to the lower surface of the plate **12** by the adhesive **44**.

Referring to FIG. **10**(*b*), in step 2, the pins **15** are inserted into the respective holes **23** of the tape carrier **20**' and into the respective holes **124** of the plate **12**. The pins **15** are pre-joined to the substrate **42**. By inserting the pins **15** into the holes **23**, each of the pads **31**' is positioned over the corresponding one of the pads **33**.

Referring to FIG. **10**(*c*), in step 3, the pads **31**' and the pads **33** are joined via solder **35** by the process shown in FIGS. **8**(*a*)–**8**(*c*). A good connection is detected by the appearance of the solder **35** at the upper surface of the tape carrier **20**'.

Referring to FIG. **11**, in step 4, the heat sink **43** is secured to the plate **12** by the nuts **141**. The adhesive **45** is provided between the plate **12** and the heat sink **43**. By securing the nuts **141**, the adhesive **45** is squeezed to become uniformly distributed and to have a smaller thickness.

Next is described the fourth embodiment of the present invention. A feature of the fourth embodiment is a modification of the means for joining the bottom legs **11** or pins to the substrate **42**. Other structures and functions of the fourth embodiment are the same or similar to those of the third embodiment.

Referring to FIG. **12**, pins **16** have first, second, and third portions **161**–**163**, respectively. The structures of the first and second portions are the same as those of the third embodiment. The diameter of the third portions of the pins **16** is approximately 0.8 mm. The third portion is plated with nickel.

In the fourth embodiment, the substrate **42** is preferably a glass polyimide-type printed circuit board which is heat resistant and has a low permitivity. In the substrate **42**, holes **48** are bored having a 0.8 mm diameter. The third portions **163** of the pins **16** are inserted into the holes **48** and joined to the substrate **42** via solder **164**. The solder **164** flows into the gap between the holes **48** and the pins **16**.

Thus, in addition to the features of the third embodiment, the fourth embodiment has the following features. A first feature is that the pins **16** are positioned precisely. Another feature is that the strength of the joint between the pins **16** and the substrate **42** is enhanced.

Next is described the fifth embodiment of the present invention. A feature of the fifth embodiment is a modification of the means for joining the lower legs **11** or pins to the substrate **42**. The other structures and functions are the same or similar to those of the third embodiment.

Referring to FIG. **13**, in the fifth embodiment, each of the pins **17** has a first portion **171**, a second portion **172**, and a third portion **173** whose diameters are approximately 1.2 mm, 1.6 mm, and 0.7 mm, respectively. The length of the second portion **172** is approximately 0.8 mm., The pins **17** are preferably made of stainless steel. The third portion **173** is threaded. In the substrate **42**, holes **48** are bored having a 0.8 mm diameter. The third portions **173** of the pins **17** are inserted into the holes **48** of the substrate **42**. The pins **17** are fixed to the substrate **42** by tightening nuts **174** threaded on the pins **17**.

Thus, in addition to the features of the third embodiment, the fifth embodiment has the following features. A first feature is that the pins **16** can be positioned precisely. Another feature is that the strength of the joint between the pins **16** and the substrate **42** can be enhanced.

Next is described the sixth embodiment of the present invention. A feature of the sixth embodiment is a modification of means for joining the lower legs **11** or pins to the substrate **42**. The other structures and functions are the same or similar to those of the third embodiment.

Referring to FIG. **14**, in the sixth embodiment, pins **18** have a first portion **181**, a second portion **182**, and a press-fitting spring **183**. The configuration of the first portion **181** is the same as that of the third embodiment.

Referring to FIG. **15**(*a*), the second portion **182** is a plate whose length is approximately 0.8 mm. The width of the second portion **182** is greater than the diameter of the holes **48** of the substrate **42** and the diameter of the holes **124** of the plate **12**.

Referring to FIG. **15**(*b*), the spring **183** has a tapered end.

Referring to FIG. **15**(*c*), the cross-section of the spring **183** is M-shaped. The spring **183** has resiliency in the direction indicated by the arrows. When the spring **183** is inserted in the holes **48** of the substrate **42**, the spring **183** tightly fits (press-fitted) in the holes **48** to fix the pin **18** to the substrate **42**.

Thus, in addition to the features of the third embodiment, the sixth embodiment has the feature that the pins **18** can easily be fixed to the substrate **42**.

Next is described the seventh embodiment of the present invention. A feature of the seventh embodiment is that the plate **12** is made wider to cover the tape carrier **20**.

Referring to FIG. **16**, in the seventh embodiment, the plate **12** has a first portion **121** and a second portion **122** which cover the LSI chip **40** and the tape carrier **20**, respectively. The LSI chip **40** is attached to the lower face of the first portion **121** by the adhesive **44**. The tape carrier **20** is attached to the lower face of the second portion **122** by an adhesive **49**. The material of the adhesive **49** is the same as that of the adhesive **44**.

The tape carrier **20** and the substrate **42** are connected via the connecting structure **30** used in the first embodiment. The connecting structure **34** used in the second embodiment cannot be used in the seventh embodiment because the upper surface of the tape carrier **20** is covered with the second portion **122** of the plate **12**.

Next is described the assembling process of the seventh embodiment.

Referring to FIG. **17**(*a*), in step 1, the LSI chip **40** is connected to the inner leads **21** of the tape carrier **20**.

Referring to FIG. **17**(*b*), in step 2, the lower surface of the LSI chip **40** is encapsulated by the resin **41**.

Referring to FIG. **17**(*c*), in step 3, the adhesive **44** is distributed over the lower face of the first portion **121** of the plate **12** or over the upper surface of the LSI chip **40**. The adhesive **49** is distributed over the lower face of the second portion **122** of the plate **12** or over the upper face of the tape carrier **20**. Thereafter, the LSI chip **40** and tape carrier **20** are

attached to the first portion **121** and the second portion **122** of the plate **12**, respectively. The adhesive is cured at a temperature of approximately 150° C. for about 10 minutes.

Referring to FIG. **17**(*d*), in step 4, pins **15** are inserted into the respective holes **23** of the tape carrier **20** and into the respective holes **124** of the plate **12**. Thereafter, the pads **31** and the pads **33** are joined by soldering.

Referring to FIG. **17**(*e*), in step 5, the heat sink **43** is attached onto the plate **12**.

In the seventh embodiment, the heat sink **43** thermally contacts the second portion **122** of the plate **12** as well as the first portion **121**. Therefore, the thermal resistance between the plate **12** and the heat sink **43** is reduced. Furthermore, the second portion **122** of the plate **12** prevents the tape carrier **20** from warping.

Next is described the eighth embodiment of the present invention. A feature of the eighth embodiment is boring holes in the second portion **122** of the plate **12** to adapt the connecting structure **34** thereto.

Referring to FIG. **18**, tape carrier **20** and the substrate **42** are connected by the connecting structure **34** used in the second embodiment. Holes **123** are bored in the second portion **122** of the plate **12**. Each of the holes **123** is positioned over the corresponding one of the pads **31**' of the connecting structure **34**. The holes **123** make visible the solder **35** which appears at the upper surface of the tape carrier **20**.

Thus, in addition to the features of the seventh embodiment, the eighth embodiment has the feature that a faulty or failed connection between the tape carrier **20** and the substrate **42** can easily be detected.

Next is described modifications of the aforementioned embodiments of the present invention.

First, the application of the present invention is not limited to the LSI chip **40**. The present invention can be applied to any type of electronic device.

Secondly, the cross-section of the bottom legs and the pins can be formed in a variety of shapes. For example, the cross-section may be rectangularly-shaped. The holes **23** of the tape carrier **20** must be shaped to fit the bottom legs and the pins.

Thirdly, the number and configuration of the upper legs, bottom legs, and pins are not limited to those of the aforementioned embodiments.

Fourthly, the heat sink **43** may be coated with insulating material (e.g., epoxy or silicone) to avoid short-circuiting among the inner leads **21**.

Fifth, the present invention can be applied to any type of cooling means other than the heat sink **43**.

The present embodiments are therefore, to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description and all changes which come within the meanings and range of equivalency of the claims are therefore intended to the embraced therein.

What is claimed is:

1. A process of assembling an electronic package, comprising steps of:

(a) preparing a supporting member, said supporting member including a plate and a bottom leg, said plate having first and second surfaces, said bottom leg having first and second ends, said first end of said bottom leg being joined to said second surface of said plate;

(b) preparing a carrier having a hole;

(c) connecting an electronic device to said carrier;

(d) attaching said electronic device to said second surface of said plate, said second end of said bottom leg being inserted into said hole of said

(e) joining said second end of said bottom leg to a substrate; and

(f) attaching cooling means onto said first surface of said plate.

2. A process of assembling an electronic package, comprising steps of:

(a) preparing a carrier having a hole;

(b) preparing a plate having a first surface, a second surface and a hole;

(c) preparing a pin having first and second ends;

(d) joining said second end of said pin to a substrate;

(e) attaching an electronic device to said second surface of said plate;

(f) inserting said pin into said hole of said carrier and said hole of said plate; and

(g) attaching cooling means onto said first surface of said plate.

3. A process of assembling an electronic package, comprising steps of:

(a) preparing a supporting member, said supporting member including a plate and a bottom leg, said plate having first and second surfaces, said bottom leg having first and second ends, said first end of said bottom leg being joined to said second surface of said plate;

(b) preparing a carrier having a first surface, a second surface, a hole, and a first pad provided on said second surface of said carrier;

(c) preparing a substrate having a first surface, second surface, and a second pad provided on said second surface of said substrate;

(d) connecting an electronic device to said carrier;

(e) attaching said electronic device to said second surface of said plate, said second end of said bottom leg being inserted into said hole of said carrier;

(f) joining said second end of said bottom leg to said first surface of said substrate;

(g) connecting said first pad of said carrier to said second pad of said substrate; and

(h) attaching cooling means onto said first surface of said plate.

4. A process according to claim **3**, wherein said step (b) includes a step of boring a through-hole in said carrier, and said step (g) includes steps of:

(g-1) providing solder on said second pad of said substrate;

(g-2) positioning said first pad of said carrier on said solder; and

(g-3) heating said solder to flow said solder into said through-hole of said carrier.

5. A process of assembling an electronic package, comprising steps of:

(a) preparing a carrier having a first surface, a second surface, a hole between said first and second surfaces, and a first pad provided on said second surface of said carrier;

(b) preparing a plate having a first surface, a second surface and a hole between said first and second surfaces;

(c) preparing a pin having first and second ends;

(d) preparing a substrate having a first surface, a second surface, and a second pad provided on said first surface of said substrate;

(e) joining said second end of said pin to said first surface of said substrate;

(f) attaching an electronic device to said second surface of said plate;

(g) inserting said pin into said hole of said carrier and said hole of said plate;

(h) connecting said first pad of said carrier to said second pad of said substrate; and

(i) attaching cooling means onto said first surface of said plate.

6. A process according to claim **5**, wherein said step (a) includes a step of boring a through-hole in said carrier, and said step (h) includes steps of:

(h-1) providing solder on said second pad of said substrate;

(h-2) positioning said first pad of said carrier on said solder; and

(h-3) heating said solder to flow said solder into said through-hole of said carrier.

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